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MANAGEMENT OF LACERATIONS OF THE GREAT VESSELS OF THE UPPER THORAX AND BASE OF THE NECK

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THE MANAGEMENT OF STAB WOUNDS of the heart and great vessels is a matter which confronts us frequently in our locality. We have previously expressed our views concerning the desirability of early thoracotomy for most patients with cardiac lacerations (3). In this report a similar viewpoint is expressed in relation to lacerations of the great vessels of the upper thorax and base of the neck.

It is safe to say that the history of the world has seen untold millions of human beings die as a result of lacerations—by the arrow, the spear, the knife, the bayonet—of the great vessels of the upper chest, by which is meant the aorta and the innominate, subclavian, and common carotid arteries, the superior vena cava, and the innominate, subclavian, and internal jugular veins. Yet the lifesaving procedure of immediate definitive surgical repair of the damaged vessels is even now being utilized only sparingly. This lack of definitive therapeutic approach is understandable in the ages prior to about 1930, for there were unsolved problems relative to anesthesia, blood replacement, and the physiologic management of open chest surgery. The advances in these ancillary fields of the past 2 decades, however, make possible today a deliberate surgical program of immediate repair of the damage and restoration of altered physiology. The demonstration that surgery of the great vessels can be carried out with great safety on an elective basis should stimulate its more extensive utilization in emergency situations.

Wounds of the great vessels of the upper thorax are frequently quickly fatal as a result of exsanguination. In regard to the arteries in particular, the sustained high pressure, the thin elastic wall, and the lack of any stout tissues to abut a clot firmly and continuously against the injured area, all militate against the quick formation and maintenance of clotted sealing of a laceration prior to the occurrence of a fatal amount of blood loss. Individuals who survive the initial episode develop massive hematomas, which may become infected and are very prone to early or late secondary hemorrhage. Great vessel injuries do not heal cleanly as a rule, and the few patients who ultimately survive usually develop an aneurysm or

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arteriovenous fistula. This dismal immediate and ultimate outlook renders appealing any program which increases the salvage rate. Patients who survive to reach the hospital alive should be regarded as salvageable by an aggressive program involving immediate thoracotomy with control of hemorrhage, rapid replacement of blood volume, cardiac resuscitative measures as indicated, and definitive repair of the injured structures. Temporization will result in loss of a patient who could possibly be saved by aggressive action, as the following case report illustrates.

CASE 1. T. H., a 30 year old colored male, was stabbed in the left side of the neck at approximately 3:00 p.m. September 9, 1956. He was taken to the University Hospital emergency room where he was treated for shock with 1,500 cubic centimeters of whole blood. His blood pressure became stable at 100/60 at which time (8:00 p.m.) he was transferred to Birmingham Veterans Administration Hospital.

On admission, the pulse was 116, respirations 24, and blood pressure 120/72 (R), 94/80 (L). There was a 4 to 5 centimeter stab wound in the left anterior portion of the neck, 2 fingerbreadths above the left sternoclavicular junction. There was a second stab wound in the left anterior second intercostal space in the midclavicular line. This wound extended downward and medially. The patient was conscious and in no distress but talked with definite hoarseness. Carotid pulses were palpable and equal. There was a diminution of the left radial pulse; coarse crackling rales were noted on auscultation of the left anterior superior lung field. Hematocrit was 43 volumes per cent. A roentgenogram of the chest was negative.

After routine laboratory work, chest x-ray examination, and cross matching of 2,000 cubic centimeters of blood, he was taken to the operating room. A No. 45 rubber catheter was placed in the left pleural space under local anesthesia. At this point esophagoscopy was attempted to rule out injury to the esophagus. Before the esophagoscope could be introduced there was a sudden gush of blood from the chest catheter and stab wound of the neck. Within 1 minute there was approximately 2,000 cubic centimeters of blood on the operating table and on the floor. While blood was being pumped into both saphenous veins, left anterior thoracotomy was done without anesthesia. The left side of the chest was full of blood and the heart in cardiac arrest. Cardiac massage was immediately instituted and 2 points of hemorrhage were found and controlled by finger pressure. These were found to be lacerations of the left subclavian artery and left innominate vein. Both structures were doubly ligated. The patient's immediate blood loss had been so massive that it was at least 15 minutes before his blood volume could be restored to near normal. Ventricular fibrillation had occurred, but a regular rhythm was obtained by electric defibrillation and massage, plus the use of adrenalin and calcium gluconate. After control of bleeding and restoration of heartbeat, the chest was closed. Severe postoperative drainage of blood from the chest was found to be due to fibrinolysis, and was treated with fibrinogen, plasma, calcium, vitamin K, and protamine sulfate. Although the patient was getting his twenty-fourth bottle of blood, he expired at 5:30 a.m. on September 10, 1956, 9½ hours after admission. At autopsy, there was a left hemothorax, and lacerations of the left innominate vein and left subclavian artery.

The secondary hemorrhage that occurred in this case is typical of the behavior of great vessel injuries. This patient should have been treated by surgical exploration of the great vessels immediately after admission. The outcome of this case, and others like it, has firmed our belief that an aggressive surgical approach is required for salvage of these individuals. In recent years we have operated on 8 such patients, with no deaths.

CASE 2. H. A., a 16 year old colored male, was admitted to the University Hospital on July 3, 1956, shortly after being stabbed in the suprasternal notch. The blood pressure was 120/72, pulse 100, respirations 30. X-ray examination showed a widened superior mediastinum. The wound bled moderately. Cardiovascular collapse developed soon after admission, and he was taken to the operating room where bronchoscopy showed marked compression of the carina. At this point the pulse and blood pressure became unobtainable, and heart action ceased. A left anterior fourth interspace thoracotomy was done. There was a large hemothorax. The cardiac asystole was treated by massage. The sternum was split vertically and the 2 incisions were joined. A 2 centimeter laceration of the aortic arch was found at the base of the innominate artery. This was controlled by finger pressure and repaired. No other great vessel injuries were found. The sternum was repaired with silver wire. A total of 9,000 cubic centimeters of blood was given. He was discharged on August 8, 1956.

This case represents the first successful instance of early repair of an aortic arch laceration, and is reported in detail elsewhere (4).

CASE 3. S. P., a 45 year old negro male, was admitted to the University Hospital on June 25, 1957,

shortly after sustaining a stab wound in the left second intercostal space just lateral to the sternum. The blood pressure was 70/50, pulse 115, respirations 28. The patient was somewhat irrational, sweating profusely, and moderately dyspneic. X-ray examination revealed a widening of the superior mediastinum with a left hemothorax. After intravenous infusion of blood was started, the superior mediastinum was entered through a vertical sternum splitting approach. There was a small hematoma in the mediastinum. There was also a 2 centimeter laceration of the left mediastinal pleura and a left hemothorax of approximately 750 cubic centimeters. The left lung contained emphysematous blebs and was fixed at the apex by fibrous adhesions. The blood was evacuated from the left pleural cavity and the internal mammary artery was found to be severed at the second intercostal space. It was doubly ligated. Exploration of the great vessels and heart revealed no further injuries. The sternum was closed with silver wire; 1,500 cubic centimeters of whole blood were given. The postoperative course was uneventful with discharge on July 19, 1957.

This case represents exploration of the mediastinum through a transsternal approach. Very extensive hemorrhage can occur from the internal mammary artery.

CASE 4. R. W., a 28 year old negro male, was admitted to the University Hospital on July 4, 1957, shortly after being stabbed with a knife in the left supraclavicular space. On admission, the blood pressure was 82/62, pulse 100, respirations 20. There was a 1½ centimeter wound in the left supraclavicular space just above the clavicle. There were decreased breath sounds over the left side of the chest, and x-ray examination revealed a left hemothorax. There were forceful carotid pulsations palpable on the left, but the left branchial and radial pulses were absent.

Under general anesthesia an incision was made above and parallel to the left clavicle. The middle one-third of the clavicle was resected subperiosteally. The subclavian vein was intact. However, further exploration revealed the subclavian artery to be severed in its second portion. An end-to-end anastomosis was done. At approximately the time this anastomosis was completed, there was a sudden gush of blood from the thoracic inlet. At this time the left thoracic cavity was explored through the third left anterior intercostal space. The left pleural space contained approximately 1,000 cubic centimeters of blood. All the great vessels were explored, but no further injuries were found. The wounds were closed; 2,500 cubic centimeters of whole blood were given. At the completion of the procedure, the forearm and hand were warm and radial pulsations were palpable. However, on the morning of July 5, 1957, no pulses

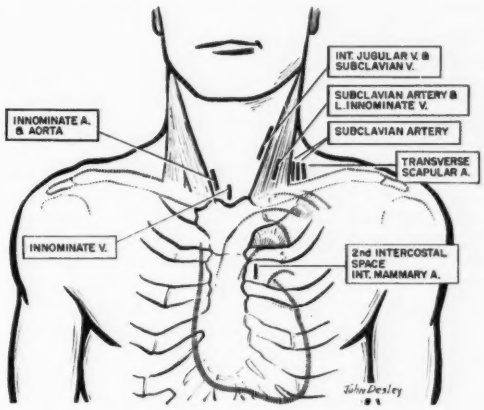

FIG. 1. Eight stab wounds and structures involved.

were palpable in the left upper extremity even though the extremity remained warm, with good capillary diffusion. Although pulses did not return, there was no loss of function and he was discharged on July 9, 1957, after an uneventful postoperative course.

This is an example of a stab wound of the base of the neck managed by exploration from above the clavicle with anastomosis of the subclavian artery. Suspicion of further great injuries necessitated thoracotomy with exploration of the upper mediastinum.

CASE 5. R. B., a 43 year old negro male, was admitted to the University Hospital in July 1957 soon after being stabbed in the neck, face, and abdomen. The blood pressure was 104/60, pulse 110, respirations 26. There were multiple superficial lacerations of the face and scalp, and a 2 centimeter stab wound in the suprasternal notch. There was no hematoma. Good carotid and axillary pulses were present. There was a 2 centimeter stab wound in the right posterior portion of the chest parallel to the vertebral border of the scapula. Further examination of the chest was negative with the exception of expiratory wheezes bilaterally. The base of the neck and anterior mediastinum were explored through a vertical sternum splitting incision, with extension into the neck along the left sternocleidomastoid muscle. A through-and-through laceration of the left innominate vein was repaired. All of the great vessels were explored, and no other injuries were found. The abdomen was then explored, but no viscera were found injured; 2,000 cubic centimeters of whole blood were administered. The patient was discharged on August 4, 1957, after an uneventful postoperative course.

This case represents an exploration of the root of the neck and superior anterior mediastinum by a sternum splitting incision.

CASE 6. M. B., a 46 year old colored female, was admitted to the University Hospital on August 4, 1957, shortly after receiving a "butcher knife" wound in the base of the left side of the neck. The blood pressure was 100/70, pulse 95, respirations 30. There was a 3 centimeter stab wound just medial to the left sternocleidomastoid muscle and approximately 3 centimeters superior to the sternum, with a moderate hematoma in this area. Left carotid and axillary pulses were present. The patient was moderately dyspneic. An initial left thoracentesis yielded 500 cubic centimeters of air and 300 cubic centimeters of blood. A catheter was placed in the left side of the chest and the patient taken to the operating room. A vertical sternum splitting incision was made, with extension along the anterior aspect of the left sternocleidomastoid muscle. After exploration of the great vessels of the mediastinum and root of the neck, a laceration was identified at the junction of the left subclavian and internal jugular veins. The innominate and internal jugular veins were ligated without difficulty. Ligation of the subclavian vein required resection of a portion of the left sternocleidomastoid muscle from the clavicle. Both pleural cavities were drained and the sternum was reapproximated with silver wire. The patient received 2,000 cubic centimeters of whole blood. The postoperative course was complicated by slight edema of the left upper extremity. She was discharged on August 14, 1957.

This case again represents exploration of the upper thorax and neck through a transsternal approach.

CASE 7. I. R., a 25 year old negro male, was admitted to the University Hospital on August 13, 1957, shortly after sustaining a stab wound in the inferior aspect of the left posterior triangle of the neck. On admission the blood pressure was 80/40, pulse 100, respirations 25. There was profuse active bleeding from the wound necessitating finger pressure hemostasis while the patient was taken straightway to the operating room. Intravenous infusion of 5 per cent dextrose with water was started, followed by blood when it became available.

In the operating room, the patient was prepared for exploration under general anesthesia. The anesthesiologist was unable to visualize the larynx, consequently intubation was accomplished through a tracheostomy. A vertical sternum splitting incision was performed and extended into the left side of the neck, anterior to the left sternocleidomastoid muscle. The innominate, left subclavian, and left internal jugular veins, the arch of the aorta, and the left subclavian and common carotid arteries were exposed and were found to be uninjured. With further exploration, the transverse scapular artery was found to be severed at its origin from the subclavian. The ends were ligated. The sternum was reapproximated with silver wire. The patient received 3,800 cubic centimeters of whole blood. The postoperative course was characterized by an elevated temperature with frequent spikes to 102 to 103 degrees. Purulent drainage developed from the neck and retrosternal space. On August 23, 1957, there was complete separation of the sternum, which was secondarily closed. He was discharged on October 21, 1957, with continued moderate drainage from the retrosternal area.

This case represents an anterior mediastinal exploration necessitated by a stab wound of the root of the neck. There was subsequent anterior mediastinitis with suppuration due to the tracheostomy contamination.

CASE 8. J. M., a 43 year old negro male, was admitted to the University Hospital on August 25, 1957, shortly after receiving a shotgun wound of the left side of the neck and the right hand. The patient was conscious, with a blood pressure of 80/40, pulse 110, respirations 28. There were multiple pellet wounds in the left side of the neck, with a large hematoma of the base of the neck. There were also pellet wounds in the left anterior part of the chest and the left shoulder. Breath sounds were absent over the left side of the chest. X-ray examination revealed a left hemopneumothorax. A chest catheter was inserted prior to surgery, with prompt expansion of the lung. Intravenous fluids were started and a tracheostomy was done in the emergency room. Under general anesthesia the anterior mediastinum was entered through a vertical sternum splitting incision which was carried down to the third interspace. The third left intercostal space was entered and the left anterior superior chest wall was reflected laterally along with the clavicle. The original vertical incision was extended into the neck along the anterior border of the left sternocleidomastoid muscle. Upon entering the left side of the chest approximately 500 cubic centimeters of blood were aspirated. There were multiple pellet wounds of the upper lobe of the left lung. Proximal control of the aortic arch branches was secured. The aorta, innominate artery, and innominate vein were intact. The internal jugular vein contained multiple pellet wounds, and so was doubly ligated. After proximal and distal control was obtained, 7 pellet holes in the left common carotid artery were repaired without impairing its distal pulsation. Several pellet wounds of the third part of the subclavian artery were repaired with some encroachment upon the lumen but with a weak pulse distally. The sternum was reapproximated

with silver wire; 3,000 cubic centimeters of whole blood were given during the procedure. Twelve hours postoperatively no radial pulse was present on the left. There were forceful carotid pulsations. Postoperatively there was a pulmonary air leak that persisted for 4 days. A superolateral empyema (hemolytic Staphylococcus aureus, Pseudomonas aeruginosa) developed, treated by open drainage. When discharged on October 1, 1957, the empyema was very small.

This case represents an exploration of the superior anterior mediastinum and root of the neck by a sternum splitting incision which was extended into the left third intercostal space.

CASE 9. W. H., a 24 year old colored male, was admitted to the University Hospital on September 17, 1957, shortly after receiving a stab wound in the left posterior cervical triangle. The blood pressure was 80/60, pulse 110, respirations 30. The wound was actively bleeding at the time of admission, with evidence of moderate shock. With continuous finger pressure hemostasis, the patient was immediately taken to the operating room. A tube was placed in the left pleural space, with removal of 200 cubic centimeters of blood. Whole blood was started intravenously, and an incision was made above and parallel to the left clavicle. The middle one-third of the clavicle was resected subperiosteally. With continuous digital pressure the third part of the subclavian artery was identified as the site of injury. After proximal and distal control was secured, a 1½ centimeter laceration was repaired. No other vessel injuries were found. The wound was closed. The patient received 2,000 cubic centimeters of whole blood. There was a weak radial pulse immediately postoperatively. However, on September 19, 1957, no radial pulse was palpable. The extremity remained warm with good function. He was discharged on September 27, 1957, after an otherwise uncomplicated postoperative course.

This case represents repair of a vessel in the base of the neck by a cervical approach which is recommended only when the injury seems sufficiently far lateral that proximal control is assured. If this control is not forthcoming, immediate thoracotomy must be done.

DISCUSSION

These case reports illustrate the gravity of the acute clinical situation which is presented. All patients had external wound sites which strongly suggested the possibility

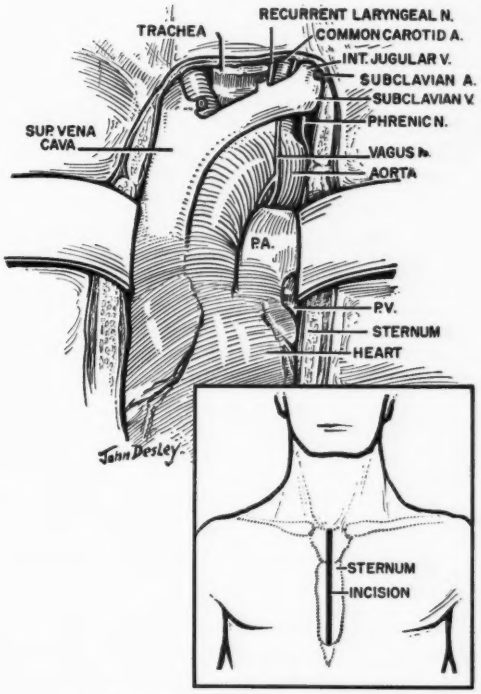

FIG. 2. Vertical sternum splitting incision.

of major vessel injury. All demonstrated moderate degrees of distress and cardiovascular collapse, although these findings were attenuated in most cases by drunkenness. There were 3 patients actively bleeding on arrival at the emergency room. Three required continuous digital pressure to control the active hemorrhage prior to definitive management. In 3 patients there were associated lesser injuries. The average length of time from injury to the arrival at the emergency room was approximately 30 minutes. Intravenous fluids or blood given in the emergency room ranged up to 3,000 cubic centimeters, some receiving none because they were taken straightway to the operating room. The mean admission blood pressure was 90 systolic with a range of 70 to 120. Three patients had a hematoma in the area of the wound. Five patients had a hemopneumothorax. There were 2 patients with a widened mediastinal shadow by x-ray

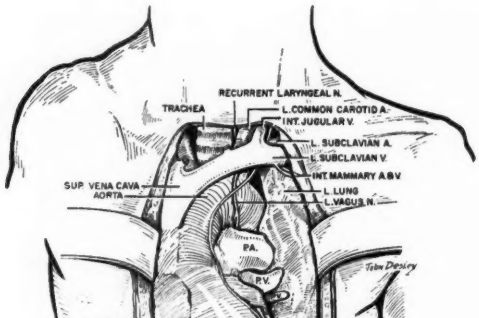

FIG. 3. Vertical sternum splitting incision with extension into left fourth intercostal space.

examination. None of the patients had evidence of cardiac tamponade. During surgery a maximum of 9,000 cubic centimeters of whole blood was used and a minimum of 2,000 cubic centimeters. With the exception of 2 patients none received more than 3,000 cubic centimeters of whole blood. Actual repair of the injured vessels was not difficult once adequate exposure and proximal control were secured. A striking feature was the stable physiologic status of these patients on the operating table following control of hemorrhage and restoration of blood volume. This improved condition was reflected also in a generally smooth postoperative course.

Adequate exposure is essential for any operation in the superior mediastinum. This is especially true in great vessel injuries because of the necessity for adequate control of hemorrhage and meticulous repair of lacerated vessels in a field containing many vital organs and distorted by hemorrhage. The problem of operative exposure of the upper mediastinum and thoracic inlet area has taxed many individuals, and many types of incision have been described. The nineteenth century witnessed the development of elective surgery, usually for aneurysm, of the great aortic branches in the base of the neck by a cervical approach, often combined with resection of varying portions of the sternum, clavicle, and first three ribs. Further progress was made in the twentieth century with the addition of sternum splitting maneuvers and deliberate entry of the pleural space anteriorly. Elective formal transthoracic transpleural ligation of the left subclavian artery was first performed by Touroff in 1941, shortly followed by similar treatment of the left common carotid artery by Coleman and the innominate artery by Bigger. Many types of approach to the vessels of the superior mediastinum have been described.

Although anterolateral thoracotomy or a cervical incision, or both, may be used, we have come to rely most heavily on the vertical sternum splitting approach (Fig. 2) and believe that it presents several distinct advantages: (1) It can be simply and rapidly performed. A skin incision plus a couple of minutes with the Lebsche knife and the mediastinum is exposed. Rapid control of hemorrhage is the key to salvage of these patients. (2) It provides excellent exposure of the heart and great vessels. In particular the superior vena cava, the innominate veins, the pulmonary artery, the ascending aorta, the aortic arch, and the innominate, common carotid, and subclavian arteries can be visualized and hemorrhage controlled. (3) This incision can be extended as the situation requires. If better exposure of the left pulmonary hilus, the aortic arch, descending thoracic aorta, left common carotid artery, or left subclavian artery is needed, lateral extension into the left third or fourth intercostal space is done (Fig. 3). (4) Postoperative discomfort is minimal if the bony parts are approximated accurately and held securely by wire. Similar exposure could be made on the right side, although we have not used it. If there is injury of a great vessel at the thoracic inlet or lower neck, the incision

may be extended into the neck along the anterior border of either sternocleidomastoid muscle, thereby exposing the carotid and subclavian arteries and the jugular and subclavian veins (Fig. 4).

Although intrathoracic proximal control of the great vessels is usually mandatory, a cervical approach with resection of a portion of the clavicle may occasionally be used if it is clear that the injury is located in the third part of the subclavian artery or distally. Clues to this location would be absence of thoracic symptoms and signs, a negative roentgenogram of the chest, posterior cervical triangle cutaneous injury with lateral direction of the wound by finger exploration, and laterally situated local signs such as hematoma and bruit. If one finds that proximal control is not possible by the cervical approach, the mediastinum should be entered immediately by splitting the sternum vertically.

Once the vessel is exposed, hemorrhage may be controlled by finger pressure, and proximal and distal control then secured. In dealing with the actual injury, careful primary suture with maintenance of vessel patency is the desired goal. A simple over-and-over everting continuous fine silk repair is satisfactory. However, it may not be possible to perform primary repair because of the nature or extent of the injury. In this event, one may insert a graft or perform simple ligation. If ligation is contemplated, one should be familiar with the sequelae of vessel ligation at certain specified points. Either innominate, subclavian, or internal jugular veins can usually be safely occluded. Ligation of both innominate veins is to be avoided, as is ligation of the superior vena cava because of the resultant morbidity from the attendant venous suffusion. In regard to the arteries, the nearer to the heart that any major artery is ligated, the better is the collateral circulation and thus the safer the procedure. The intrathoracic portion of either subclavian artery may usually be ligated safely. Ligation of the innominate artery fails to produce gangrene of the upper extremity; however, there is a reported 9 per cent mortality from cerebral complications. Ligation of the cervical portion of the subclavian artery and the axillary artery is accompanied by a low incidence of gangrene and is preferably avoided. Ligation of the common carotid artery is hazardous, with a reported mortality of 20 to 30 per cent, and a high incidence of cerebral complications, particularly in the aged.

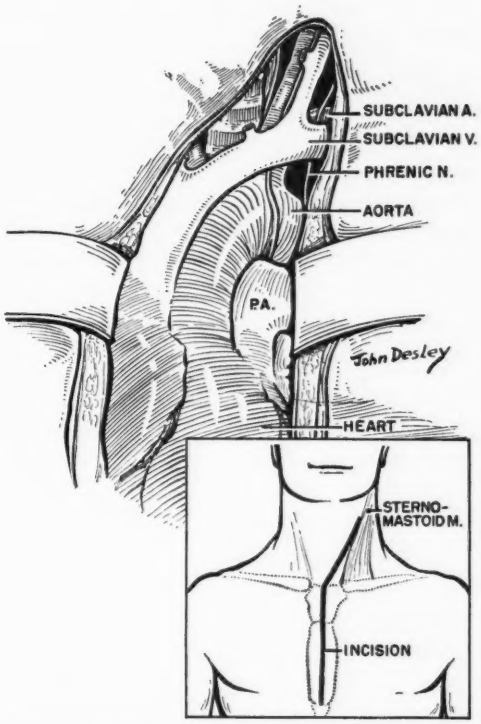

FIG. 4. Vertical sternum splitting incision with extension along the anterior border of sternocleidomastoid muscle.

SUMMARY

Lacerations of the great vessels of the upper thorax are usually quickly fatal as a result of exsanguination. Recent advances in anesthesia, blood replacement, physiology of the open chest, and surgical techniques today permit the utilization of immediate deliberate thoracotomy for control of hem-

orrhage, repair of damaged structures, and restoration of normal physiologic status.

Based on experience with 9 patients, clinical findings, the exposure gained from various operative approaches, and the management of the injured vessels are discussed. All 8 patients treated by immediate thoracotomy survived. Patients who arrive alive at the hospital should be regarded as salvageable by immediate operative intervention.

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TETANUS, A PREVENTABLE DISEASE

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EACH YEAR in the United States between 500 and 600 people die of tetanus. This loss of life is unnecessary because tetanus is a preventable disease. The record of the armed services during the past 40 years demonstrates this fact. During World War II there were only 5 cases of tetanus in the United States Armed Services in individuals who had had routine immunization and a booster following injury. Two of these died. This contrasts with an incidence in the British Army in September 1914 before the use of antitoxin of 9 cases of tetanus for every thousand injured personnel. Even after the introduction of tetanus antitoxin (TAT) the incidence in that group remained higher than 1 per thousand injured. There were 2,385 patients with tetanus in the British Army in World War I, and 1,011 of these died. The large decrease in incidence in World War II is attributable to the active immunization against tetanus of the United States troops. This difference in incidence is even more dramatically brought out by the fact that the German and Japanese troops in that war were not thus immunized. Unofficial reports have it that the disease was rampant. Fifty-three cases of tetanus in German prisoners-of-war were seen in 1 month in one Allied hospital. In another hospital there were 10 cases among 3,500 patients. There were 150 cases in the nonimmunized civilian population associated with the United States forces in the Okinawan campaign. In 1945 in the battle for Manila there were 500 cases of civilian tetanus, an incidence of 40 for every thousand wounded. In Germany from 1949 to 1951 there were 1,894 cases with a 49 per cent mortality. According to the National Office of Vital Statistics the civilian death rate 5 to 10 years ago was 0.2 per 100,000 population, approximately the same death rate as that of diphtheria, and much higher than that of typhoid and smallpox. During World War II more than 1,500 people in the United States died of tetanus, while in the Armed Services only 2 persons died. Tetanus has an appreciable incidence and a high mortality. It is preventable by the use of active immunization.

The purpose of this article is to review the nature of tetanus, its treatment, and prophylaxis. A special plea is made for more widespread prophylaxis in the civilian population so that this almost entirely preventable disease may become a rarity if not a nonentity.

HISTORY

Tetanus is a disease which has long been known to man and it is accurately described in the works of Hippocrates and Aretaeus. Man's early familiarity with the disease was no doubt related to his contact with the soil and to the animals used in tilling it.

It was not until the end of the last century, however, that the bacterial nature of the disease was discerned. In 1884 Nicolaier first caused experimental tetanus by the injection of soil into animals. He also described the drumstick bacilli now named Clostridium tetani. Five years later Kitasato was able to isolate the bacteria in pure culture. He and Behring laid one of the foundations of the science of immunology by the immunization of animals with tetanus toxin. They also demonstrated the neutralization of toxin with antiserum.

Debate as to the pathogenesis of tetanus has continued since the work of Meyer and Ransom and some others in 1903 who be-

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lieved that the toxin spread centripetally up the motor nerves to be fixed in the anterior horn cells. In a series of papers about 1935 Abel and his co-workers at Johns Hopkins propounded the theory that the toxin was not spread centripetally, but humorally. He did not believe that ascent via the nerves was possible and reported experiments showing that the toxin was spread via the lymphatics and venules. Wright, Roofe, and Baylis and associates within the past 10 years have come to the defense of the older theory with new experimental evidence. Data in support of each of these possibilities seem well enough substantiated to suggest truth in both theories. One of the greatest steps in man's study of tetanus was the development of toxoid by the formalin neutralization of toxin. This was the work of Ramon in France in 1925.

ETIOLOGIC AGENT

Tetanus is caused by the action of a bacterial exotoxin on the central nervous system. The toxin is elaborated by a gram positive drumstick-shaped rod which is a spore-former. Clostridium tetani does not tend to invade as do clostridial bacilli of gas gangrene. It remains localized and very few bacteria are needed to produce enough toxin to cause clinical tetanus. This is one of the reasons that the organism is hard to isolate in a case of tetanus. The spores are very resistant to destruction. Boiling alone will not kill them. They may lie dormant within a healed wound for years only to become vegetative after certain changes in conditions about the wound. The organisms are strictly microaerophilic. Their normal habitat is within the gastrointestinal tract of many animals. They are not commonly found in man, except in the case of frequent contact with animals. The spores are obviously found in well tilled soil.

PATHOGENESIS

The bacilli or their spores may be carried into any wound from contaminated skin, or via foreign material. Their multiplication is favored by anaerobic conditions such as a closed wound, or one in which there is necrotic tissue. Minerals in soil promote necrosis, and thus their presence in a wound favors the growth of the bacteria. Spores in a healed wound may become activated following later surgery, and Campbell reported a case of fatal tetanus following excision and grafting of a healed wound on the leg. It has also been known to follow tooth extractions, insect bites, and "clean" surgical procedures.

The toxin elaborated by the bacillus acts in the central nervous system. Its mode of travel is uncertain; some evidence favors spread along the motor nerves, and other evidence suggests that the transport is humoral. Once in the central nervous system the toxin becomes fixed, and then cannot be neutralized by antitoxin. The latter thus is effective only on circulating toxin. The rate of ascent varies, and this incubation period can be as short as 24 hours or as long as 2 or 3 weeks. The much longer incubation periods probably represent stimulation of dormant spores already present in the tissue. No recognizable histopathologic changes are noted.

DIAGNOSIS

Tetanus may be limited to the injured extremity, or local spasm in an extremity may be the initial sign of the disease. This local tetanus suggests that the irritation of the central nervous system may be limited to the affected part. More frequently trismus is the first symptom of the disease. The spasms gradually progress throughout the body. Dysphagia, opisthotonos, a rigid but nontender abdomen, spasm of the facial muscles (the classical risus sardonicus), and laryngospasm are other notable signs and symptoms. Trivial stimuli, such as bright illumination or a jarring of the bed, may trigger gross spasms or convulsions. Death most frequently is brought about by asphyxia following prolonged spasm of the inspiratory muscles. Initially other causes for trismus must be kept in mind such as parotitis or

the status following dental extraction. Sometimes a hysterical trismus is noted in a patient aware of the signs of tetanus. Diagnosis should never be based on bacteriology because the organism is very difficult and often impossible to recover. In one series it was isolated in only little more than half of the cases in which recovery was attempted. The discovery of the wound of entrance may frequently be unobtainable either by history or physical examination.

PROGNOSIS

The prognosis varies with the facilities available for treatment. Ideally the patient should be under the combined care of internists, surgeons, and anesthesiologists. In such clinics the mortality is down to 5 to 10 per cent or less. With poorer care the rates can be as high as 80 to 90 per cent; many rates are recorded in the neighborhood of 40 per cent. The longer the incubation period, the better the outlook. If this period is less than 7 to 10 days the mortality is almost twice what it is with longer incubations. The prognosis is also poorer if the interval between the onset of trismus and convulsions is less than 24 hours.

TREATMENT

Since the disease kills because of its symptoms, treatment is directed toward their control. The three broad aims in therapy are: (1) the neutralization of toxin and prevention of any further elaboration thereof; (2) the prevention of spasms which cause both acidosis through increase of lactic acid and, more importantly, respiratory paralysis; and (3) the prevention of pneumonia and other complications. Fixed toxin, of course, cannot be dealt with. The elaborated toxin is neutralized with massive doses of TAT. This antibody will also take care of any more toxin which may be formed by the nidus of infection. It is best to give all of the TAT initially, as sensitivity and faster excretion of the foreign protein can develop if it is given intermittently. After the appropriate skin tests 50,000 immunizing units are given intravenously, and another 50,000 intramuscularly. This will afford protective levels for 5 to 6 weeks. The intrathecal route is contraindicated, because it not only does not afford any extra benefit, but it may also damage the nervous tissue in its own right. Some have advised the local injection of 5,000 to 10,000 units of antitoxin around the wound before treating it surgically. Others believe that this is an unnecessary refinement. The wound should be treated in accordance with general surgical principles. Thorough débridement with the removal of necrotic tissues and foreign material is of importance. No dead spaces should be left. Meleney advised irrigation and packing when indicated with activated zinc peroxide. Some wounds can be completely excised. Neutralization of the toxin is more important than the care of the wound.

The spasms are very painful and distressing to the patient who is mentally alert until acidosis and respiratory depression affect the sensorium. The most serious spasms are those affecting the larynx, the diaphragm, and the intercostal muscles. These result in asphyxia and death. Control of spasms is accomplished with various sedatives and muscle relaxants. Rectal avertin has been used widely, but has the danger of severe rectal irritation. Short acting barbiturates such as amobarbital can be used continuously intravenously. The rate of infusion can be modified to titrate the level of sedation according to the degree of the patient's irritability. Too much sedation should be avoided as this will excessively decrease the cerebral oxygen utilization. Curare can be given, but for sufficient relaxation total curarization is necessary and the patient is essentially under general anesthesia and must be kept in a respirator with constant attendance of an anesthetist. Mephenesin is a relaxant which does not act at the myoneural junction like curare, but acts apparently between the cortex and the spinal ganglion cells, at the internuncial neurons. It is superior to curare in that total relaxa-

tion and controlled respirations are not necessary. As suggested by Diaz-Rivera it may be given intravenously, but it is very irritating to the venous walls. Adriani suggested giving it via Levin tube or by proctoclysis. Forbes presented 15 consecutive cases with recovery in which the treatment completely relied on the use of sedatives without the use of any relaxants. Adjunct drugs such as the ataractics and cortisone have been recommended. The former will decrease the amount of sedation necessary. The advantages of cortisone are not borne out as the remainder of the regimen in most of the reports suggesting its use was not optimal.

Of the greatest importance is the early performance of a tracheotomy. This procedure eliminates the problem of laryngospasm and greatly facilitates the proper toilet of the tracheobronchial tree. If the operation is delayed, the stimulus of the procedure may precipitate irreversible spasms and death.

Pneumonia is one of the more serious of the secondary complications. It is prevented by the careful handling of the secretions through the tracheotomy. Prophylactic antibiotics are used. Penicillin and the broad spectrum antibiotics are also active against the tetanus bacillus; they are, of course, ineffective against the toxin. Cardiac arrhythmias and decompensation, fecal impaction, urinary retention, decubitus ulcers, and traumatic glossitis are among the other complications preventable by excellent nursing care. Special attention must be paid to fluid and electrolyte balance. High humidity may prevent the inspissation of bronchial secretions which are then impossible to remove. Oxygen may be indicated. Oral feedings should be avoided until the convalescent stage, and even nasogastric tube feedings will not prevent the possibility of vomiting and aspiration. During the convalescence, active immunization against tetanus should be carried out, as clinical tetanus will not render the patient immune to the disease. Much more constant medical attention is required for the patient with tetanus than with almost any other disease. Nursing care must be constant and excellent, and the physician must attend the patient more frequently than with the usual 2 or 3 daily visits.

PROPHYLAXIS

The difference between the 1,500 to 2,000 deaths in the United States civilian population in 4 years, and the 2 deaths in the Armed Services during the same interval is not due to superior treatment of tetanus, but to its prevention by the use of active immunization. Most of the recommendations which follow are from the report of a committee studying immunization against tetanus published in 1954 (14).

Active immunization against tetanus is induced by 3 injections of alum precipitated toxoid (0.5 c.c.) at intervals of 3 to 6 weeks. A booster dose should be given every 4 to 5 years, or at the time of an injury. The more slowly absorbed precipitated toxoid (APT) should be used for the routine booster. The emergency booster should be the more rapidly absorbed fluid toxoid (FT), which will give protective levels within 4 days. The dosage is 0.5 cubic centimeter. It is particularly important to have active immunization in patients prior to the manipulation of any old wounds which might contain tetanus spores.

An unimmunized patient with a suspect wound should be passively immunized. The usual dose for a wound seen within 24 hours is 3,000 immunizing units of TAT. In seriously contaminated wounds or in the event of coexisting vascular disease or diabetes, the prophylactic dose should be doubled. A lower dose is recommended by some, but others believe that a smaller dose is not adequate. The higher dose has a longer duration of action, lasting 10 to 14 days rather than the 7 days afforded by the 1,500 unit dose. If there is delay before the wound is seen, the dose should be doubled for each day of elapsed time since the injury up to a total of 10,000 to 12,000 units. If a wound remains suspicious under observation, the dose of TAT may be repeated every 7 days, or better, a

very heavy dose (up to 100,000 u.) may be given. With repeated doses the likelihood of sensitization increases; a large dose is not more likely to sensitize than a small one, and it has a longer duration of action.

Because of the dangers of anaphylaxis and serum sickness TAT should be used only in those whose wounds present a reasonable suggestion of contamination with tetanus spores. Judgment is easy with wounds in which such contamination is either certain or most improbable. The decision is more difficult between these extremes. Active immunization of the entire population would circumvent this difficulty. Sensitivity tests should be performed prior to serum administration. Even before this, a positive or negative allergic history or history of previous serum administration should be elicited. If this history is positive an ice bag, a tourniquet, and 1 cubic centimeter of 1:1000 aqueous adrenalin should be in a syringe at the bedside. Fatal reactions to the skin test have occurred before these items could be obtained. The skin test is performed by raising an intradermal wheal the size of a pinhead by using $^1/_{10}$ cubic centimeter of antitoxin diluted 1:10. If the allergic history is positive use a 1:100 dilution. If the skin test is equivocal or if the skin is melanotic so that erythema would be difficult to judge, the conjunctival test is used. A drop of antitoxin diluted 1:100 times is placed on the conjunctiva. After 20 minutes, the absence of erythema and induration or of conjunctival injection indicates probable lack of sensitivity. It should be remembered that negative skin tests render immediate reaction unlikely, but have nothing to do with delayed reaction or serum sickness. If the sensitivity test to equine TAT is positive similar tests may be performed with bovine antitoxin. If there is sensitivity to both sera, the serum of a recently actively immunized human may be used. Following immunization there are high levels for 2 months, with the maximal level at about 3 weeks. This serum would contain from 10 to 30 units of antitoxin per cubic centimeter. Positive skin tests, known sensitivity to horse serum, previous serum therapy, or a strong allergic history make serum therapy very dangerous, and the indications for its use should be carefully reviewed.

Questions may arise as to the program to be followed in certain unusual situations such as the following: If a patient who has received only the initial dose of APT presents with a suspect wound, he should be given TAT prophylactically as protective levels of antibody are not reached until after the second of the basic doses. If a patient has had a booster within 6 months he would not need another booster should another injury occur within that length of time. The duration of protective levels of antitoxin estimated at 0.1 unit per cubic centimeter of serum and the rapidity and height of response after booster has been well studied by Stafford, Looney, and other workers. In certain conditions in the actively immunized individual it may be advisable to give both TAT and the FT booster. A person receiving radiation may have interference with his antibody response, and TAT might be given to that patient whose response to the booster might be delayed or absent. If there is a massively contaminated wound with heavy trauma the incubation period is likely to be less than a week. Passive immunization with TAT would protect for those first days till the secondary immune response to the booster elevated the active antibody level. TAT does not delay this secondary immune response.

Whenever passive immunization is given, the patient should simultaneously be started on active immunization. The reasons for this are threefold: First, the possibility of serum sensitivity being present if antitoxin therapy is ever needed again exists. Second, if there is sensitivity and the patient is desensitized, there is evidence that a therapeutic level cannot be achieved even with desensitization because the foreign protein will be excreted at a greatly accelerated rate. Cases have been reported in which TAT failed to prevent tetanus in a patient previously given TAT, and such failures have been seen

both with and without the presence of clinical serum sensitivity. Third, active immunization is better protection. It should be noted that the toxoid should be given in a separate syringe and in a different extremity from the TAT. APT and not FT should be given. Thus there is little if any clinical antagonism between the two. There is evidence that there is slightly prolonged passive immunity when the two are given together. There is a delay in the development of active immunity, but this is not significant if the full basic immunizing dose is given. Some recent experimental work suggests the superiority of antibiotics to TAT as prophylaxis, but this is not well enough worked out to allow its clinical application. Active immunization, of course, is the indicated method of prophylaxis.

DESENSITIZATION

Desensitization is only rarely needed for prophylaxis, but it should be used for treatment when indicated. The principle is to give slightly increasing doses to prevent the development of anaphylaxis. This does not truly desensitize the patient but causes a gradual fixation of his antibody. The outline presented is from the *Handbook of Medical Treatment* by Chatton and associates. Antihistaminics should be given first. Adrenalin should be in the syringe (1 c.c. of 1:1000), and an ice bag and tourniquet should be present. Under constant medical observation the following doses should be given every 30 minutes.

1st dose: 0.1 c.c. of TAT diluted 1:10
2nd dose: 0.2 c.c. of TAT diluted 1:10
3rd dose: 0.5 c.c. of TAT diluted 1:10
4th dose: 0.1 c.c. of TAT undiluted
5th dose: 0.2 c.c. of TAT undiluted
6th dose: 0.5 c.c. of TAT undiluted
7th and subsequent doses until the administration of the entire dose: 1.0 c.c. undiluted TAT every 30 minutes.

Should a mild reaction occur, back down to the next lower dosage and then continue as before. If the reaction is more severe the adrenalin should be given intravenously. The TAT injection site should be cooled with ice and isolated from the circulation with a tourniquet. The treatment should either be discontinued or advanced even more slowly than this schedule suggests. Cortisone and ACTH, contrary to some reports, are of no value in treating immediate serum reactions; their value is in the treatment of delayed serum sickness.

ANAPHYLAXIS

In case of severe anaphylaxis, such as sudden cardiorespiratory arrest, it may be necessary to give the adrenalin directly into the heart. Since the death is cardiac and respiratory, cardiac massage would be indicated. Milder symptoms of immediate serum reaction are breathlessness, chest pain, pruritus, and urticaria. Acute anxiety and fear of imminent death may be present.

SERUM SICKNESS

Though anaphylaxis is a type of serum sickness, the latter term is usually reserved for the delayed reaction following the injection of foreign protein by 8 to 12 days. The signs and symptoms are local or generalized edema, urticaria, pruritus, fever, arthritis, and lymphadenopathy. Antihistaminics and analgesics may suffice for the management of this complication, but the disease may be severe enough to require the use of ACTH or cortisone. More rarely, there are serum reactions which affect the nervous system. Berger and Sachs reviewed reports of this type of reaction. Trueb reported a compensation case following an industrial accident in which brachial plexus neuritis with pain and paresis followed the prophylactic use of TAT. Other such reactions include perceptive deafness, ocular palsy, hemiplegia, isolated peripheral nerve palsies, aphonia, and others. These are of varying duration.

The reported incidence of serum sickness following TAT varies greatly. Moynihan cited an incidence of 5.3 per cent and said that half of these reactions were anaphylactic. Hampton recorded reports of anaphy-

laxis varying from 1/50,000 to 1/200. Newell and McVea gave an incidence of serum sickness of 11.8 per cent. It is apparent that different standards of judgment are used in these reports.

Early in the use of toxoid some mild and transitory reactions were reported, but with further purification the incidence of these has dropped. Twelve years ago the Army had an incidence of 2 reactions per 100,000 injections. There are probably even fewer reactions now.

DISCUSSION

A comparison of the incidence of tetanus in an actively immunized population with that in a nonimmunized population, the death rate of the disease in spite of advances in therapy, and the complications (some serious and even fatal) of passive immunization all lead to but one conclusion: the populace should be actively immunized with tetanus toxoid. This should be a major project in public health. At present in New York State passive but not active immunization is compensable. This situation should be changed. In the event of national catastrophe, such as atomic warfare, this immunization would save even more lives than suggested by the present incidence of the disease. To ensure the proper therapy in case of an emergency, the patient should carry a card indicating accurately the date and type of immunization received. All physicians should be alert to this problem and could readily immunize a large sector of the people without great difficulty. The APT is supplied without charge by the New York State Health Department. With a little publicity among the laymen even more of the people could be afforded this protection which they give their children but do not have for themselves. Veterans are now about 12 years or more past the receipt of their last booster, and in order to maintain their protection should receive reinjections without delay. Frank Glenn wrote: "In my clinical experience, I have never seen such a terrifying disease as tetanus." Certainly all should be done that can be done to eliminate this disease.

SUMMARY

1. The significance of tetanus in the United States today is presented. Between 500 and 600 people die each year of the disease.

2. The incidence of the disease in the Armed Forces during World War II was practically nil.

3. The history, bacteriology, pathogenesis, and diagnosis of the disease are reviewed.

4. An outline of treatment of clinical tetanus is presented with emphasis on (a) neutralization of the circulating toxin, (b) adequate sedation to prevent spasms and convulsions with consequent respiratory death, (c) early tracheotomy to ensure an adequate airway and proper cleansing of the tracheobronchial tree, and (d) constant medical attention.

5. Programs of active and passive immunization are presented with a review of the precautions to be taken prior to the injection of a foreign protein.

6. Complications of the use of antitoxin are presented along with the means of combatting them.

7. A plea is made for much greater use of tetanus toxoid in active immunization to prevent the needless loss of time and life from either the disease or a now outmoded method of prophylaxis against that disease.

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GAS CYSTS OF THE INTESTINE (PNEUMATOSIS INTESTINALIS)

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PNEUMATOSIS INTESTINALIS is being reported with increasing frequency in the American literature. It is known under various descriptive names: intestinal emphysema, gas cysts of the intestine, bullous emphysema of the intestine, peritoneal pneumatosis, cystic lymphopneumatosis, and various others. Pneumatosis intestinalis is probably the most widely recognized name for this condition.

HISTORY

The condition was first observed by Du-Vernoi during dissection of a cadaver in 1730. In 1876 Bang reported finding it at autopsy. Hahn was the first to recognize the similarity between the disease in animals and that in human beings. He applied the name "pneumatosis cystoides intestinorum" to the human disease. His observation was also the first one on a living person. The first case in the American literature was reported by Finney in 1908. Several reports have appeared in the United States in the last two decades. Jackson in 1940 collected all the reported cases and adding a case of his own brought the total number to 172. In a careful review of the literature Koss in the year 1952 found a total of 255 cases.

CLINICAL FINDINGS

The scarcity of the reported cases is undoubtedly due to the rarity of the condition. The disease is better known to veterinarians as it occurs more frequently in lower animals, particularly in pigs. In humans, cysts varying in size from a few millimeters to several centimeters may be found in the stomach, small intestine, colon, or mesentery. Occasionally, the cysts may perforate and give rise to free air in the peritoneal cavity. The gas containing cysts are predominantly mucosal and submucosal in infants and subserosal in adults. Chemical analysis of the gas from a cyst in 1 of our own cases showed 89.96 per cent nitrogen, 7.62 per cent carbon dioxide, and 2.42 per cent oxygen. This is in agreement with the finding of MacKenzie, Urban, and Sauser-Hall. The condition is found more frequently in patients in the middle age group but has been reported in premature infants as well as old people. MacKenzie, reviewing the world literature in 1951, found 32 cases in the pediatric age range; to that number she added 12 patients less than 1 year of age and 1 boy, 6 years old. In children, the condition is often associated with poor general health. Four of our cases were in babies with intractable diarrhea. In adults the disease may be asymptomatic and be revealed only at autopsy or it may be discovered as an unsuspected finding on radiographic examination. When the cysts involve the distal colon they may be visualized on proctoscopy as was done in Case 7. In this case the examiner had been alerted to the diagnosis as a result of a previous barium enema. On proctoscopy the cysts may bear a superficial resemblance to polyps. The cysts are easily compressible and in our case had a bluish white sheen with numerous small superficial blebs distinguishable on their surface.

Pneumatosis intestinalis is often associated with other lesions of the gastrointestinal tract such as peptic ulcer, carcinoma of the stomach, inflammatory ulcerations of the intestine, appendicitis, or intestinal obstruc-

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FIG. 1. a, Case 1.; b, Case 4. Opened sections of the colon showing submucosal cysts protruding into the lumen. Some of the cysts at the periphery have been cut open by the section (arrow).

tion from various causes. Koss in 1952 reviewed 213 cases and found the condition to be associated with gastric or duodenal ulcer in 55 per cent of the cases. Most of the ulcers were found to be of the stenotic type.

COMPLICATIONS

Although frequently asymptomatic, pneumatosis intestinalis may give rise to such complications as partial obstruction, volvulus of the intestine, adhesions, and tension pneumoperitoneum.

ETIOLOGY AND PATHOGENESIS

Of the three theories given to explain the cause of the disease, neoplastic, bacterial, and mechanical, the latter would seem the most probable. The mechanical explanation presupposes a break in the continuity of the mucosa due to distention of the intestine by gas which is then forced through the mucosal defect into the submucosa or subserosa forming cyst-like collections. In some cases the cysts are scattered and involve widely separated segments of the gastrointestinal tract. To explain this finding, Stiennon suggested that the gas spreads along the mesentery under pressure. This would explain the predominantly serosal location of the cysts.

The neoplastic and bacterial theories are lacking in histopathologic or bacterial confirmation.

ONSET AND COURSE

It is not clearly known how fast pneumatosis intestinalis can develop nor is the natural course of the disease well understood. Dale and Pearse reported the appearance of cysts in a 5 week interval between exploration and autopsy for a carcinoma of the stomach. There is evidence to show that the cysts may disappear spontaneously in certain cases whereas in others they may last for a prolonged period.

The course of the disease is to a great extent dependent on the site of gas accumulation. Mucosal location of the gas may cause localized areas of necrosis, ulceration, and even perforation. Bacterial invasion of the wall of the colon may occur secondary to the mucosal ulceration and result in a bacterial colitis. Mucosal location of gas is most commonly seen in children and when complicated by ulceration may cause severe diarrhea and electrolyte depletion with fatal outcome.

The subserosal variety of gas is less dangerous. The gas may rupture into the peritoneal cavity and be resorbed, rupture back into the lumen of the bowel, rupture retroperitoneally in the fixed parts of the colon, or extend into the lymphatics and distend the cisterna chyli.

PATHOLOGY

The gross pathologic findings are dependent upon the site and severity of the disease. When associated with pyloric or duodenal obstruction, the proximal small intestine is involved, whereas the ileum and large in-

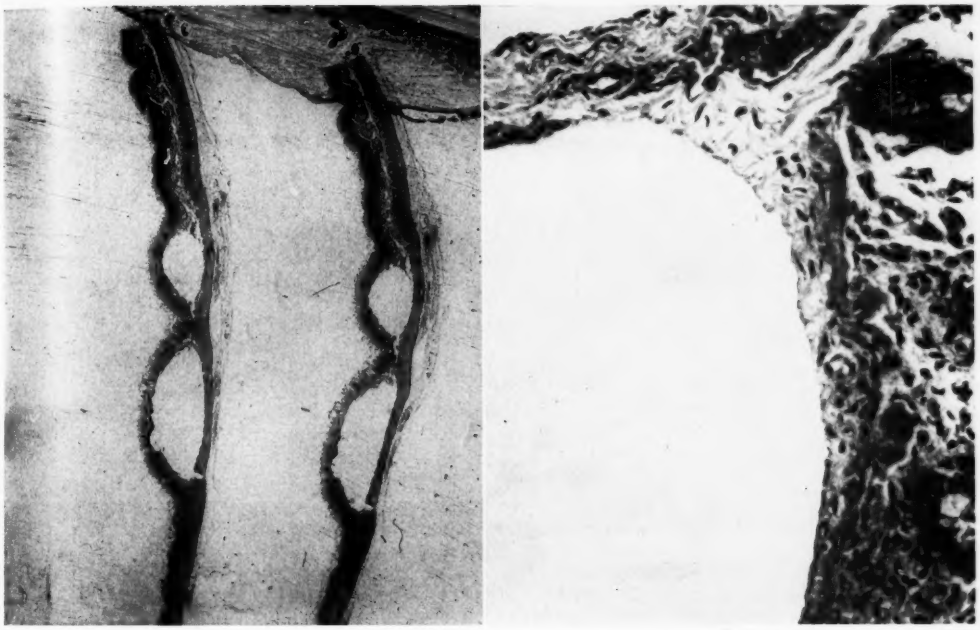

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FIG. 2. Case 4. a, Microscopic section of the colon showing air cysts dissecting between the submucosa and muscularis and causing a bulge of the mucosa into the lumen. b, High power magnification taken along the border of an air cyst showing absence of a cyst wall and a nonspecific cellular infiltration.

testine are more likely to be involved in the presence of diarrhea. The cysts may vary in size from a few millimeters to several centimeters in diameter. They may occur as isolated cysts or may be found in clusters. Usually they do not communicate with each other. Submucosal location of the cysts may cause almost complete occlusion of the lumen of the involved segment of intestine (Fig. 1). On occasion the cysts have been found to form an adherent mass which may cause obstruction from extrinsic pressure or volvulus. Gas may infiltrate the mesentery and produce localized mesenteric cysts. Occasionally cysts will perforate producing a pneumoperitoneum.

Microscopic examination usually reveals no interruption of intestinal mucosa or points of gas entry when the cysts are either mucosal in location or associated with peptic ulcer or ulcerative colitis. The cysts generally have no well defined lining membrane but may on occasion be covered by a flat endothelial layer lending support to the opinion that they represent distended lymph spaces. The microscopic picture is usually that of a nonspecific inflammation which in all probability is a foreign body reaction to the presence of the gas (Fig. 2). Wright has been able to produce a chronic inflammatory response with the formation of epithelial cells by injecting gases in the subcutaneous tissue of animals under sterile conditions.

RADIOGRAPHIC APPEARANCE

It is important that the clinical and radiographic features of this entity be recognized when present. Unfamiliarity with the disease may lead to the erroneous diagnosis of a perforated viscus, polyposis, or neoplasm. Pneumatosis intestinalis should be con-

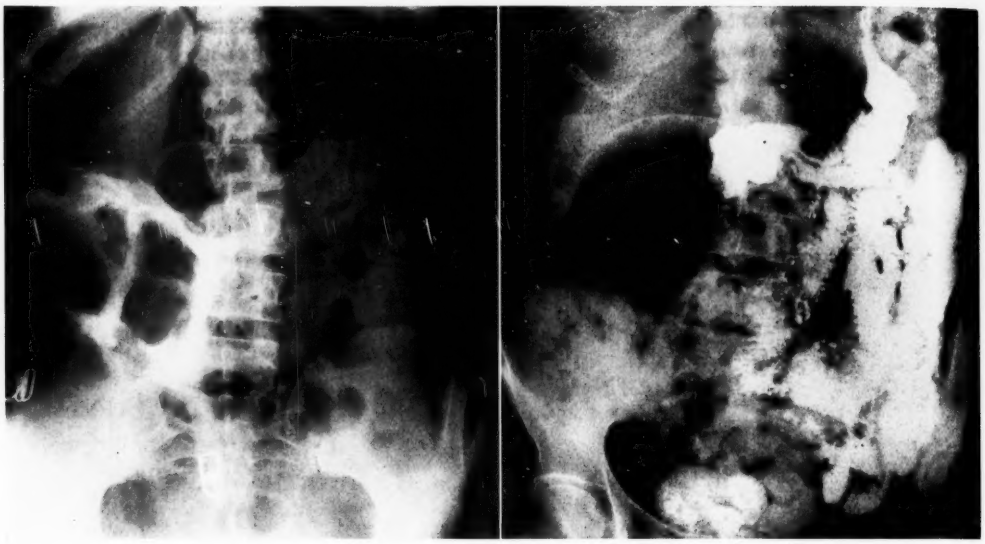

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FIG. 3. Case 6. a, Flat plate of the abdomen showing gas pockets in the right side of the abdomen. The gas pattern is unlike that seen in intestinal distention. A gastrointestinal series and a barium enema done a few days later show the gas to be outside the intestine. b, Large gas cyst in the right side of the abdomen showing no communication with the intestinal tract.

sidered in any patient having free air under the diaphragm but lacking the clinical picture of perforation and peritonitis.

Gas cysts of the mesentery may be suspected on a scout film of the abdomen when bizarre relatively fixed midabdominal gas collections, not conforming to the pattern of intestinal gas, are present. Small intestinal and barium enema studies will show that the cyst-like gas collections are outside the intestinal tract (Fig. 3a and b). Intramural location of the cysts by barium contrast studies of the stomach, small intestine, or large bowel will be indicated as sharply marginated polyp-like defects resulting in varying degrees of obstruction (Fig. 4). When there is a small bowel involvement, there may be interposition of a loop of bowel between liver and diaphragm. This has been referred to as the Chilaiditi sign.

DIFFERENTIAL DIAGNOSIS

Emphysematous gastritis may be hard to differentiate radiographically from pneumatosis cystoides as both are characterized by the presence of gas in the stomach wall. Clinically, however, the two conditions are quite different. Emphysematous gastritis is primarily an acute infection of the stomach causing abdominal pain, nausea, vomiting of blood, prostration, fever, and leucocytosis with a progressively downhill course. Four out of the 5 cases reported by Henry and Welch and Jones ended fatally. The clinical picture is that of phlegmonous gastritis with which it is often associated. This is in contrast with the benign course of pneumatosis intestinalis, which usually occurs as an incidental finding and produces no symptoms unless there is an associated mechanical complication in the form of obstruction of the stomach or duodenum.

Interstitial emphysema of the stomach has also been reported following gastroscopy. The air seen in this condition has a tendency to spread along the tissue planes in thin lines whereas in pneumatosis intestinalis it forms emphysematous blebs. The history of

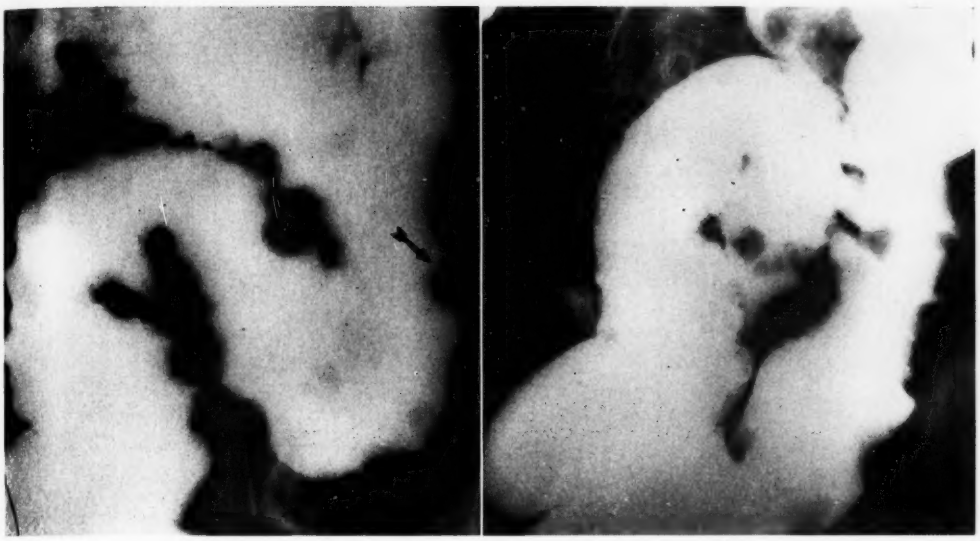

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FIG. 4. Case 7. a and b, Barium enema showing gas cysts along the wall of sigmoid and descending colon indenting and narrowing the lumen. Arrow points to extraluminal intramural gas.

gastroscopic examination and the quick disappearance of the intestinal air within 72 hours should also help in the differential diagnosis.

Advanced ulcerative colitis may simulate pneumatosis coli radiographically in that both conditions may produce a polypous, honeycombed appearance on barium enema examination. In pneumatosis coli the appearance is due to air cysts in the wall of the bowel and the true condition can be recognized by the identification of accumulations of gas along the margins of the bowel. The filling defects in ulcerative colitis are caused by islands of inflamed and edematous mucosa and these pseudopolyps do not produce the marginal ring-like lucent defects of the air cysts. Lateral views of the colon are particularly helpful in the radiographic differentiation. The clinical picture is, of course, quite different in the two conditions (Fig. 5a and b).

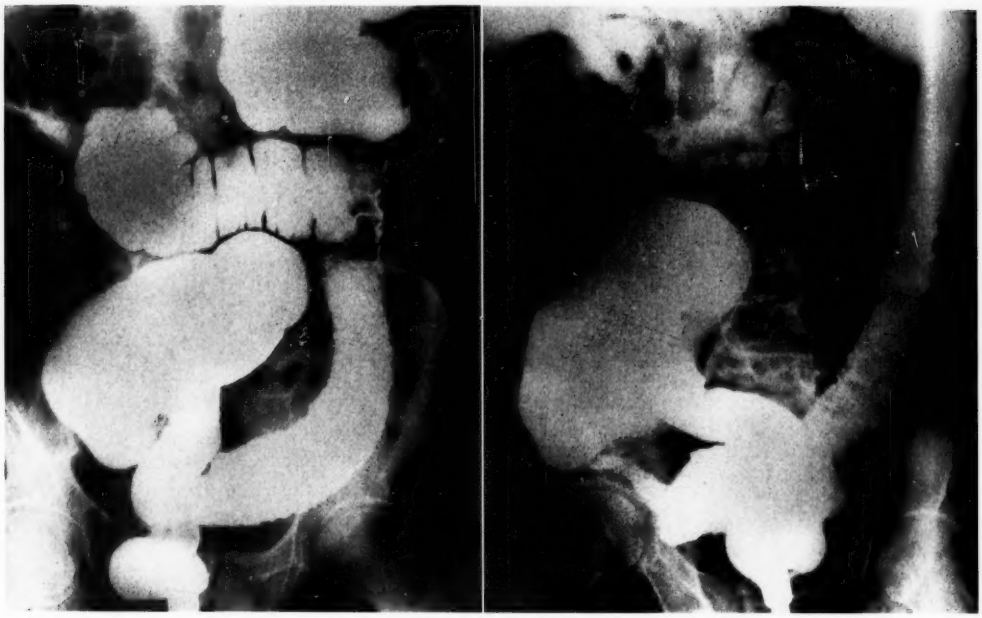
Pneumoperitoneum. The diagnosis of pneumatosis intestinalis should be suspected in any patient who has free air in the abdominal cavity but who does not have the clinical symptoms or signs of a perforated viscus (Fig. 6).

REPORT OF CASES

The following 7 cases have been collected from the official records of The New York Hospital:

CASE 1. M. M., a 2 months old white female, was admitted to The New York Hospital on April 5, 1935 because of nasal congestion. The child was a 7 months premature infant delivered at home after a normal pregnancy and labor of a primipara. Both parents showed a 4 plus Wassermann in all antigens. On admission the infant had the symptoms and signs of congenital syphilis. Radiographic studies confirmed this diagnosis. Pertinent laboratory studies revealed the Kline and Wassermann tests to give a 4 plus reaction to both antigens.

Immediately upon admission, because of the extremely poor condition of the patient, she was given a transfusion and parenteral fluids. She then began to eat better and slowly gained weight. On 2 occasions during the first week in the hospital spirochetes were found in the nasal snuffle material. One week after admission treatment with mercurial inunctions and weekly neoarsphenamine was started. One week after the start of antisyphilitic treatment the skin lesions cleared, snuffles ceased, and no spirochetes could be found in the nasal scrapings.



a b

FIG. 5. a, Proved case of ulcerative colitis. The indentations along the border of the colon are smaller, shallower, and more frequent than in pneumatosis. When seen *en face* the raised mucosa showed filling defects that simulate pneumatosis intestinalis. b, On profile these filling defects are seen to have a soft tissue density in contradistinction to the air density seen in pneumatosis.

On May 27, 1935, approximately 1 month after admission, the patient began to have several loose, green stools a day accompanied by loss of weight. The antileutic therapy was stopped and the patient was given protein milk without any regression of symptoms. The diarrhea and weight loss continued until June 3, 1935 when she expired. At autopsy the diagnosis of congenital syphilis was confirmed. The other pertinent findings related to the gastrointestinal tract were as follows: The stomach was of normal size and shape. The small intestine contained a moderate amount of thick deep bile stained fluid material. The large intestine from the cecum to the splenic flexure, especially the ascending colon, contained innumerable gas blebs within its wall. The air pockets varied in size measuring to 4 millimeters in diameter. This part of the intestine was placed in a fixative and when opened similar gas bubbles were found to be very prominent under the mucosa (Fig. 1a).

CASE 2. S. D., a 3 weeks old white girl was admitted to The New York Hospital on July 27, 1937 with the chief complaints of vomiting, thrush, and nasal discharge. The delivery and neonatal period had been normal. On admission to the hospital the baby weighed 2,760 grams, her temperature was 38 degrees C., and her general condition was described as rather debilitated but not acutely ill. The skin was dry and somewhat loose without loss of turgor. There was slight enlargement of the posterior cervical glands. The right ear drum was red, the left drum was slightly dull. The physical examination was otherwise noncontributory. The nose and throat cultures as well as culture from the blood and stools were negative. Urinary examination showed 1 plus albumin, 16 white blood cells per high power field, and a moderate amount of casts.

In the hospital the patient was treated for parenteral diarrhea, and attention was directed at improving the general condition. Two days after admission purulent material was released from both ears on myringotomy. Culture of the purulent material was overgrown with Proteus vulgaris. There was a temporary improvement in the diarrhea which soon recurred, and the patient's condition kept deteriorating until she expired 2½ weeks after admission.

At autopsy, the esophagus, stomach, duodenum, and jejunum were normal. In the ileum there were areas of hyperemia of moderate size. The terminal ileum showed an area sharply demarcated from the normal mucosa containing innumerable bullae varying in size from 1 to 5 millimeters in diameter and

filled with gas. The same findings were also noted in the large bowel especially in the transverse colon. There were a few widely scattered, discrete, small areas of bluish discoloration measuring 1 millimeter in diameter in the ileum and large intestine. One such area in the ascending colon was ulcerated in its center. The postmortem diagnoses were: (1) enterocolitis with ulceration of the ascending colon; (2) pneumatosis of the terminal ileum, ascending and transverse colon; (3) extreme emaciation.

CASE 3. Z. H., an 8 months old white male was admitted to The New York Hospital on August 15, 1938 with the chief complaint of vomiting for the past 6 months. On admission the temperature was 37.6 degrees C., weight 6.5 kilograms. The child appeared chronically ill and poorly nourished. The diagnosis of parenteral diarrhea and acute enteritis was made. Stool cultures resulted in the isolation of a gram negative motile bacillus of the Salmonella group. Agglutination tests were positive for the Salmonella paratyphi group. Various forms of treatment were of no avail and the child died on the twenty-seventh hospital day.

Autopsy showed scattered small superficial hemorrhages in the mucosa of the stomach. Much of the small intestine was distended, particularly the proximal portion. Microscopic sections of the proximal ileum and the jejunum showed areas of mottled blood stained discoloration in which there were gray superficially necrotic areas. The lower 10 centimeters of the ileum showed the mucosa thrown into rounded folds, spongy in consistency, which on section, revealed loculated collections of gas. The loculations were in the mucosa and the submucosa. Nowhere in this segment of ileum was there evidence of ulceration of the mucosa. Microscopic examination of the distal ileum showed irregularly shaped clear spaces scattered throughout the mucosa in places widely separating the mucosa from the underlying structures. None of the clear spaces had a distinct lining membrane. An inflammatory reaction was present about the clear spaces with polymorphonuclear leucocytes and wandering mononuclears as well as an accumulation of lymphocytes.

CASE 4. C., a 2 weeks old premature baby girl, was admitted to The New York Hospital on February 8, 1939 because of frequent soft stools. At delivery which had been uncomplicated, the baby was in good condition and weighed 2,020 grams. In the hospital the diarrhea was uncontrollable and increased in severity in spite of treatment. Blood and stool cultures were negative. On the twenty-fourth hospital day the baby in this instance died of parenteral diarrhea.

Autopsy showed partial distention of the intestine with small gas bubbles under the serosa of the distal ileum and colon. There was hyperemia of the mucosal lining throughout the jejunum and ileum. Two small ulcers were found in the terminal ileum, these were superficial and less than 2 millimeters in diameter. The intestinal mucosa was thrown into small rounded folds and section showed gas pockets beneath the mucosa or serosa. More prominent bulges of the mucosa were noted in the ascending colon; these were also formed by gas pockets. Microscopic examination of the jejunum showed definite thickening of the submucosa by connective tissue and some infiltration with wandering mononuclears, the lymphatics contained numerous lymphocytes, the mucosa was poorly preserved and contained more wandering cells than usual. The ileum and colon showed similar but more marked changes and in addition polymorphonuclear infiltration was noted. Culture of the intestinal content showed Bacillus coli communis and enterococci.

CASE 5. K. C., a 60 year old male, was admitted to The New York Hospital on November 29, 1954 because of memory difficulty for 2 months. He had a history of chronic lymphatic leukemia for more than 10 years treated with one course of ACTH 5 years prior to admission and cortisone shortly before admission. Past history, family history, and systemic review were all noncontributory. The pertinent positive physical findings were an enlarged liver and spleen. His white blood count on admission was 380,000 with 97 per cent lymphocytes. X-ray examination of the chest on admission showed a right superior mediastinal mass thought to represent an enlarged thyroid and a small ill defined density at the base of the right lung. A ventriculogram indicated no abnormality.

A diagnosis of chronic lymphatic leukemia and cerebral atrophy was made. The patient was given 100 milligrams of cortisone a day. On December 29, 1954 there was a sudden rise in temperature 38 degrees C., but no obvious site of infection could be detected. A roentgenogram of the chest taken on the following day showed free air under the right diaphragm (Fig. 6). The patient denied abdominal pain. The abdomen was soft and no tenderness could be elicited; the bowel sounds were active. The following day the patient had moist rales and scattered rhonchi throughout both lungs and his pharynx continued to fill with clear mucus requiring constant suction. Respiratory distress became worse and the patient expired on January 4, 1957.

An autopsy was performed and the following diagnoses were established: (1) malignant lymphoma and lymphatic leukemia; (2) diffuse sclerosis of the frontal lobes of the brain; (3) carcinoma of the right lung; (4) bronchopneumonia; (5) adenoma of the thyroid; and (6) pneumatosis coli. Grossly the colon was described as showing a moderate amount of gas beneath the mucosa. Microscopically the mucosa was separated from the submucosa by a large space, presumably air bubble. No endothelial lining or evidence of inflammation could be detected upon examination.

Case 6. R. I., a 43 year old female was admitted to The New York Hospital on December 25, 1955, 1 month after being delivered by cesarean section for placenta previa at another hospital. On returning from the delivery room she noted distention of the abdomen which persisted. The patient had a benign postoperative course and was discharged on the ninth postoperative day. Five days later, she noted increased abdominal distention, severe low quadrant pain, and temperature of 103 degrees F. She was readmitted to the hospital. Scout film of the abdomen demonstrated a marked pneumoperitoneum. Paracentesis was performed, and 2,000 cubic centimeters of air were removed. Ten days later another 5,000 cubic centimeters of air were removed. The patient continued to accumulate air rapidly and was transferred to The New York Hospital. The systemic review and family history were noncontributory. There was some dullness to percussion at the base of the left lung. Both sides of the diaphragm were high. The abdomen was dome-shaped and protuberant, tympanitic to percussion. There was no localized tenderness. No organs were palpable. Bowel sounds were normal. Urine, serology, and blood chemistries were all normal. A review of submitted films taken prior to admission showed free air under the right leaf of the diaphragm and large radiolucent irregularly shaped gas pockets in the right abdomen. One such pocket was huge and occupied the right abdomen between the liver and iliac crest. X-ray studies at The New York Hospital showed a left lower lobe pneumonia and free air under the right leaf of the diaphragm. Scout films of the abdomen showed the same findings as on the submitted films.

A gastrointestinal series including the small and large intestine showed no direct communication between the abdominal gas pockets and the intestine. The radiologic diagnosis was pneumatosis intestinalis with mesenteric gas cysts, some of which had perforated producing a pneumoperitoneum.

On the fifth hospital day a paracentesis was done and an undetermined quantity of air was removed. Chemical analysis of the air showed 7.62 per cent carbon dioxide, 2.42 per cent oxygen, and 89.96 per cent nitrogen. After the last paracentesis the patient failed to reaccumulate air. She improved rapidly and on the thirteenth hospital day was discharged in good condition. Nine months after discharge from the hospital the patient was well and asymptomatic.

Case 7. M. B., this 56 year old female was admitted to The New York Hospital on January 31, 1956 because of pain and swelling of the right knee secondary to trauma. Subsequent examination and laboratory tests led to the diagnosis of familial vascular purpura, with bleeding into the right knee joint. Physical examination was negative except for moderate superficial varicosities over both thighs and moderate postmenopausal osteoporosis.

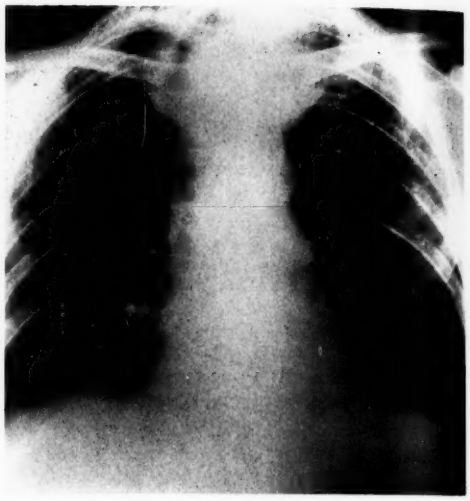


Fig. 6. Case 5. Free air under the right side of the diaphragm in a patient without the clinical symptoms of perforated viscus. Autopsy 5 days later showed pneumatosis coli.

A barium enema done as part of the general work-up revealed innumerable cyst-like filling defects throughout the entire large bowel (Fig. 4). These round sharply defined defects appeared to be subserosal gas collections, typical of pneumatosis intestinalis. In the hospital attention was focused on the right knee, the pneumatosis of the colon was considered innocuous. The patient responded to treatment to her right knee and was discharged to the care of her physician.

Sixteen months later on June 6, 1957 she was readmitted to the hospital because of recent onset of loose stools in which there was blood mixed with mucus. In the interval between hospitalizations she had had no intestinal complaints but a multitude of other bizarre symptoms thought to be on the basis of a moderately severe psychoneuroses. Physical examination was unremarkable. Proctoscopic examination revealed an amazing picture of numerous polypous masses filling the lumen of the bowel. These measured 4 to 5 millimeters in diameter with one being 4 to 5 centimeters in diameter. They were easily compressible, had a bluish white tinge, and numerous small blebs could be visualized on the surface.

They were photographed through the proctoscope (Fig. 7). Radiologic examination of the intestinal tract revealed a normal stomach, duodenum, and small intestine. Barium enema study again revealed the extensive pneumatosis of the left colon without significant change in appearance since the previous examination.

FIG. 7. Case 7. Proctoscopic picture of gas cysts in the colon of Case 7.

DISCUSSION

Pneumatosis intestinalis is an uncommon disease of the gastrointestinal tract in humans but a not uncommon finding in lower animals, especially pigs. It is characterized by the presence of loculated collections of gas in the walls of any of the components of the intestinal tract or the mesenteries. The condition may be found in all age groups.

In babies the association of pneumatosis intestinalis and diarrhea has been reported by various authors, particularly MacKenzie, who wrote in 1951, "It can be stated that diarrhea is the most frequent complaint of infants found at autopsy to have pneumatosis." The 4 babies in our series all had intractable diarrhea (Cases 1 to 4). Two of the infants had ulcerations through which gas may have dissected into the walls of the intestine (Cases 2 and 4).

In adults the disease is frequently asymptomatic and is revealed at autopsy or as an unsuspected finding on radiographic examination. When symptomatic it is the result of a complication such as partial obstruction, volvulus, or tension pneumoperitoneum. Intestinal gas cysts are associated with gastric or duodenal ulcer in approximately 50 per cent of the cases and are associated with all types of intestinal lesions in approximately 75 per cent of the cases.

The intestinal cysts have a characteristic radiographic appearance on barium contrast examination frequently permitting a definitive diagnosis. The radiographic evidence of pneumoperitoneum in a patient not having the symptoms or signs of a perforated viscus should also strongly suggest the condition. Air cysts in the mesentery may also be identified by radiographic examination.

In the differential diagnosis, emphysematous gastritis may simulate pneumatosis intestinalis radiographically but clinically they are quite different. The polypous appearance of the colon in advanced ulcerative colitis may on a barium enema bear a superficial resemblance to pneumatosis coli.

Case 6 in our series although without anatomic confirmation is none the less considered to represent pneumatosis intestinalis because of the characteristic radiographic picture. The large loculated extraintestinal gas collections on the scout film of the abdomen in this case are undeniable. In Case 7 the barium enema revealed the characterized radiographic appearance of this condition and the cysts were visualized on proctoscopy. The recognition of the condition in both instances prevented what would have been a useless exploration.

SUMMARY

The clinical, pathologic, and radiologic features of pneumatosis intestinalis, an uncommon affliction of the gastrointestinal tract in humans, have been reviewed. The differential diagnosis has been discussed and 7 cases have been reported in detail in this article.

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A HISTOCHEMICAL EVALUATION OF CARCINOMA IN SITU OF THE CERVIX UTERI

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ONE OF THE TRULY SIGNIFICANT advances in gynecology during the past several decades has been the recognition that invasive cervical cancer may be preceded by noninvasive cancer in a high percentage of cases. Today, the consensus holds that these early lesions of the cervix are actual cancers, as the name carcinoma in situ and its synonyms, intraepithelial and noninvasive cancer, indicate. Treatment properly carried out during this preinvasive stage of the disease assures the patient a permanent cure. But, one wonders if certain enigmas peculiar to this disease, including its name which employs the word "carcinoma," have not prejudiced the popular attitude toward treatment of this condition. Unlike invasive cervical cancer, carcinoma in situ is not a clinical lesion with visible alterations in the appearance of the mucous membrane. The only reliable evidence of its existence is in its histologic appearance. Moreover, the critical questions concerning its biologic position and potency, its existence as an entity or as preinvasive carcinoma are incompletely answered in spite of extensive research efforts in recent years. Here lies the great burden of responsibility which rests upon the clinician who must concern himself with the intricacies of histologic diagnosis in deciding upon a proper course of clinic management for these patients. It is imperative that pathologists and surgeons have a mutual understanding of the condition, its histologic criteria, and biologic potential, if treatment is to be uniformly sound, not unduly radical in some cases and unjustifiably conservative in others.

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Several thousand cases of carcinoma in situ of the cervix have been reported to date. A very superficial perusal of this material calls attention immediately to the obvious wide variation in lesions thus classified. The critical reviewer is handicapped further by inadequate or poor photographic illustrations in many published reports. Since it is essential to know first that carcinoma in situ is present and secondly that an invasive carcinoma is not present, the validity of diagnosis depends largely upon the type and amount of tissue examined. Frequently, the transition from normal tissue to carcinoma in situ, or even to invasive cancer, is gradual, taking place over a width of several millimeters or even several centimeters. Involvement of endocervical glands is common, and as long as the lesion is confined within the gland structure, the diagnosis remains carcinoma in situ. The difference between serial section, step-section, and the serial block examination should be appreciated. Although multiple independent foci of carcinoma in situ in the cervix are occasionally noted, the serial block technique will demonstrate that the great majority of apparently separate foci are in reality extensions of serpiginous borders of a single lesion. These lesions may extend to involve a large area without becoming invasive. Clinically evident cervical cancer appearing a short time after a positive biopsy of carcinoma in situ more often than not reflects inadequate tissue available for study in the initial examination. Furthermore, in some cases of carcinoma in situ, because of the problems inherent in the attempt at three dimensional interpretation from a two dimensional specimen, it may be difficult or impossible to evaluate apparent invasion without the

FIG. 1. Normal cervical epithelium showing PAS stainable material in the prickle and superficial cell layers. PAS, × 410.

benefit of an adequate "cone" of cervical tissue.

The histologic changes diagnostic of carcinoma in situ should meet certain minimal criteria if one is to evaluate its potentialities. Unfortunately, the histologic criteria set forth to distinguish advanced degrees of basal or reserve cell hyperactivity, dysplasia, or bizarre squamous metaplasia from carcinoma in situ of the cervix uteri are subject to errors of individual interpretation. The usual definition of carcinoma in situ, namely, a histologic lesion in which epithelial cells, remaining within the normal limits of an intact epithelial layer, exhibit the profound morphologic abnormalities that are characteristic of malignant growth, without invasion, leaves much to individual appreciation and interpretation. Moreover, one is called upon to make a histologic diagnosis and infer from it the biologic potential of the lesion. This problem has been highlighted by several recent surveys in which identical sets of slides of various cervical lesions studied by several competent pathologists resulted in a wide variation in the incidence of carcinoma in situ. The purpose of the present report is to review the material from our cases of carcinoma in situ in order to seek reliable histologic criteria for diagnosis, to search for a reliable method of identification of the basement membrane, and to attempt evaluation of the biologic peculiarities of the lesion.

PRESENT STUDY

The present study constitutes a careful histologic and cytochemical appraisal of cervical tissues obtained from 42 patients with carcinoma in situ admitted to the gynecologic service of the Albany Hospital during the 8 year period from September 1947 to September 1955. Cases diagnosed during the past 2 years are not included because of inadequate follow-up. The diagnosis was established by cervical biopsy in 31 patients. In the remaining 11 cases this lesion was identified in uteri surgically removed because of leiomyomas, adenomyosis, diffuse pelvic endometriosis, and chronic salpingitis. In addition to the material obtained by biopsy in 31 patients, the uterus soon became available for study in 26 of these same patients. Multiple blocks from the cervices of all specimens were carefully examined by using hematoxylin and eosin preparations and many special stains.

The periodic-acid-Schiff (PAS) procedure proved to be the simplest and most reliable of the many staining techniques used for demonstrating the basement membrane beneath the cervical epithelium. It was also observed that the periodic-acid-Schiff stain offered a concomitant histochemical evaluation of maturation of cervical epithelial cells. The deepest layers of the ectocervical epithelium, and the inner 2 to 3 cell layer of the stratum germinativum, normally do not contain stainable material. Proceeding to-

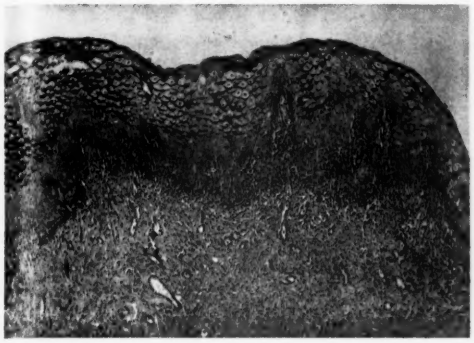

FIG. 2. Basal cell hyperactivity. Note the sharp line of demarcation between the glycogen-free basal cells and the PAS stainable material in the superficial zone. PAS, × 55.

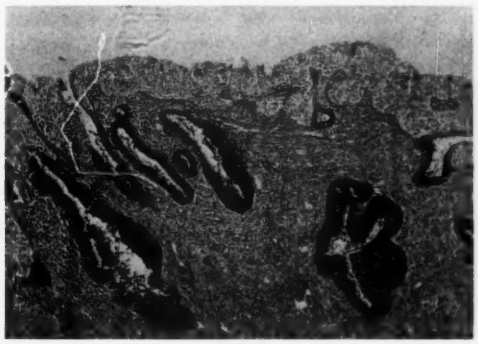

FIG. 3. Carcinoma in situ (basal cell type). Entire thickness of surface epithelium is made up of glycogen-free basal cells sharply contrasted with heavy PAS staining of columnar endocervical cells. PAS, × 55.

ward the surface, the cells contain a progressively increasing amount of substance which is PAS stainable (Fig. 1).

Also, the reserve cells of the endocervix contain no PAS staining material. The presence of intracytoplasmic glycogen in normal cervical epithelial cells and its absence in neoplastic cells is the biochemical basis of Schiller's iodine tinctorial test. Because of the lack of sharp specificity, this gross staining technique is used clinically merely to determine the proper cervical site to biopsy. Histologically, however, the PAS stainable cytoplasmic content within the cells of the various layers of the epithelium was found to serve a useful purpose in determining progress of epithelial maturation and metaplasia.

This experience corroborates previous work by one of the authors (6) with PAS staining of cervical tissue from pregnant women. An increase in positive staining material was noted in the epithelia of the cervix during pregnancy, both in the ectocervix and in the endocervix. The material was undoubtedly not all glycogen, but glycogen probably constituted the greater proportion. It was found in the squamous epithelium of the ectocervix and to a lesser extent in its intercellular spaces. The more superficial squamous cells were most heavily laden, but the basal cells of the ectocervix were wanting in most instances. In fact, there appeared to be a sharp line of demarcation between the basal cell and the more superficial cell layers. The latter cell layer most often took a rather heavy glycogen stain. This rather consistent difference in staining qualities was utilized to help determine the extent of basal cell hyperactivity in surface epithelium (Fig. 2). In the cases of marked basal cell hyperactivity only the most superficial cells are positively stained and in carcinoma in situ the entire thickness of the surface epithelium is made up of basal cells that are essentially glycogen free (Fig. 3). The surface and alveolar columnar epithelia of the endocervix contain considerable glycogen, and the amount seems to be related to the hyperactivity of the glandular elements. Hyperplastic or anaplastic reserve cells appearing in the endocervix, however, do not take the stain and, thus, are readily distinguishable from the ordinary columnar epithelium or squamous metaplasia of the mature type.

Minimal quantities of PAS stainable material are seen in certain areas showing squamous cell carcinoma with stromal invasion, particularly in fairly well differentiated lesions. It has been our impression that the higher the histologic grade of malignancy and the more anaplastic the cell type, the less glycogen there is likely to be in the tissue. This impression, however, needs fur-

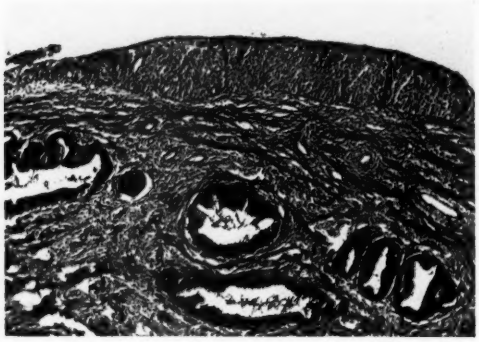

FIG. 4. Carcinoma in situ (basal cell type). A sharp basement membrane is outlined. PAS, × 55.

ther documentation before considerable reliance is placed upon it.

The tissues from 42 cases of carcinoma in situ from biopsy and hysterectomy specimens were accordingly stained with hematoxylin and eosin and periodic-acid-Schiff techniques. The in situ nature of this lesion could be appreciated by the demonstration of an intact basement membrane (Fig. 4). The distinction of early invasion and simple extension into the neck or body of an endocervical gland could be made objectively (Fig. 5). From the nuclear characteristics of the cells of carcinoma in situ and the demonstration of the absence of cytoplasmic PAS positive material, it was apparent that the epithelial proliferation was due to hyperplasia of the cells in the basal layers. The

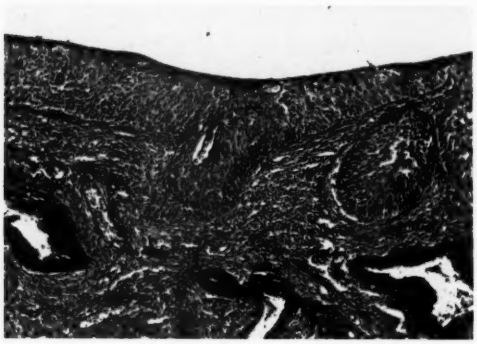

FIG. 5. Carcinoma in situ (basal cell type). The extension into and filling of endocervical glands by glycogen-free malignant cells is readily apparent. PAS, × 55.

evidences for hyperplasia included the increased cellularity, increased number of mitoses, and crowding of cells with loss of polarity. The findings of hypercellularity is linked not only to an increase in the number of cells but to an increase in the proportion of any unit area occupied by nuclei, with a concomitant increase in the nuclear-cytoplasmic ratio.

The diagnosis of carcinoma in situ depends upon the loss of cell maturation, altered epithelial pattern, hypercellularity, and cellular atypia, and these features are manifested in both stratified epithelium of the ectocervix and in endocervical epithelium (Fig. 6). Atypia is manifested by individual cells throughout the entire thickness of the epithelial layer which exhibit macronucleosis, macronucleoli, anisonucleosis, and nuclear and cytoplasmic pleomorphism. Features of cytoplasmic pleomorphism include foci of dyskeratosis and oligocytoplasmosis. Irregular and massed chromatin clumps may be prominent and lend a basophilic tinctorial effect to the epithelium. Mitotic figures are nearly always increased in number, frequently in the superficial layers. Alterations in polarity of cellular orientation occur when the cells fail to take their normal position and appearance; normal flat squames are not evident in the surface zone. Thus, in simplest terms, carcinoma in situ appears to result from atypical hyperplasia with failure of maturation in the basal cells of the exocervix or in the reserve cells of the endocervix. The reserve cell atypia is further complicated by failure in differentiation. The latter lesion is commonly seen in carcinoma in situ, and our experience agrees with other investigators who think of carcinoma in situ as a disease primarily of the endocervix.

Although the foregoing histologic changes are manifested at some point in the cervical epithelium of all cases studied, the resultant pattern is not entirely consistent throughout. In the basal cell lesion, cellular atypia due to complete failure of maturation throughout all layers up to the surface of the

epithelium is the chief feature. When the lesion appears in the endocervical canal, there is atypical hyperplasia of the reserve cells with absolute failure in differentiation as well as in maturation. The surface epithelium is frequently thinner and less regular than in the ectocervix. Many of the endocervical glands may be completely filled with immature and undifferentiated reserve cells while others may show cells with varying degrees of maturation. There is usually an irregular loss of normal cellular polarity, but occasionally the perpendicular polarity of cells to the basement membrane, normally found only in the basal layer, persists throughout the entire thickness of epithelium. One may see contiguous areas of normal epithelium, basal cell hyperactivity, and carcinoma in situ appearing in the same section of cervical tissue. In several specimens it was possible to follow the course of the cervical epithelium by serial section to an area where the basement membrane was breeched, thus excluding these cases from the present study. Accurate diagnosis is therefore dependent upon the amount and type of cervical tissue available for examination.

Another histologic variant, occasionally noted in our cases of carcinoma in situ, was characterized by cellular atypia in the intermediary epithelial zone. Certain of these areas, often contiguous or coexisting with typical lesions of the basal cell type involving the surface epithelium or glands, simulated the original description of "precancerous dermatosis" reported by Bowen who observed the evolution of this lesion into invasive cancer (Fig. 7). In Bowen's disease (1, 2) all gradations of intermixture of apparently benign and malignant cells may be found, but the malignant cells are limited chiefly to the midzone epithelial layers; the surface cells are irregularly differentiated (Fig. 8). This variant is occasionally seen in the cervix and is characterized by atypical hyperplasia with delayed or irregular maturation at the prickle cell layer. The epithelium may be altered by the development

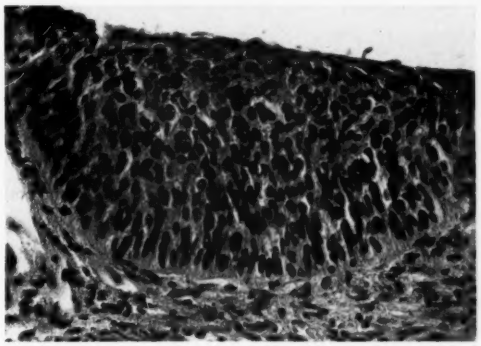

FIG. 6. Carcinoma in situ (basal cell type). Loss of cell differentiation, hypercellularity, and cellular atypism throughout the entire thickness of the epithelial layer. Hematoxylin and eosin, × 285.

of large, deep, club-shaped epithelial pegs throughout the basal zone where there may be either marked cellular atypism of a malignant pattern or a fairly normal appearing basal zone (Fig. 9).

The authors are interested in subjecting patients with this cervical lesion to prolonged follow-up, but we have been reluctant to classify definitively or treat such cases as carcinoma in situ unless the typical basal cell lesion previously described is also demonstrable in the tissue. It is usually possible to demonstrate the latter areas if sufficient cervical tissue has been submitted for study. The precise significance of this Bowenoid change occurring as a single

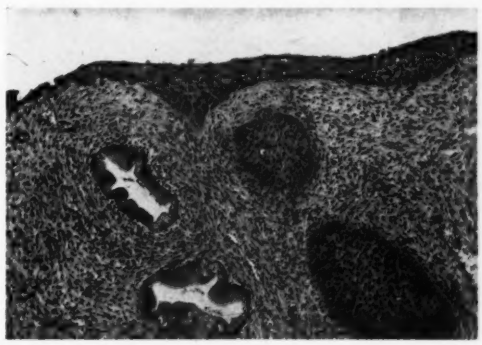

FIG. 7. Bowenoid variant. Intraepidermal prickle cell hyperplasia with gland involvement. Glands are filled with atypical reserve cells. Hematoxylin and eosin, × 55.

FIG. 8. Bowenoid variant. Prickle cell lesion with extreme cellular atypia. Overlying superficial cells are normal. Hematoxylin and eosin, × 410.

lesion is unknown, as is its biologic potential; but it is interesting to speculate that cervical cancers of the differentiated types may arise in these atypical areas.

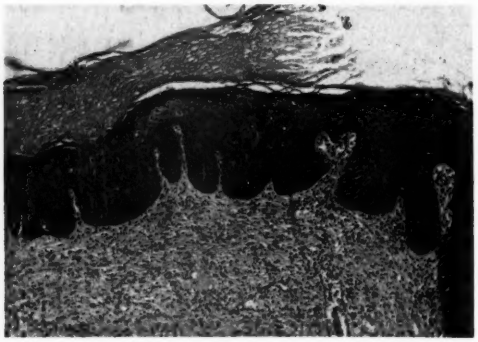

FIG. 9. Bowenoid variant. Club-shaped epithelial pegs throughout the basal zone with marked atypia of prickle cell zone and fairly normal appearing basal zone. Hematoxylin and eosin, × 55.

A careful histologic study was made also of 20 uteri showing a variety of benign, hyperactive, and even atypical changes in the cervix. In none of these cases was there any doubt that the epithelial changes, although atypical and occasionally bizarre, were not characteristic of carcinoma in situ. Although hyperactivity of the basal (or reserve) cells occurred in some of the cases, the combination of failure in differentiation and failure in maturation, characteristic of carcinoma in situ was not observed. The biologic characteristics of these cervical lesions are diagrammatically summarized in Table I. The biologic concepts set forth are simple and are in keeping with those advanced for the diagnosis of carcinoma in situ in the bronchus and in other areas of the body.

In 46 per cent of the uteri examined in which the diagnosis had been established by biopsy, no residual carcinoma in situ was identified. This low incidence of residual disease in the operative specimen is undoubtedly due to eradication of the lesion in the course of diagnostic workup. In our clinic the cervix is ordinarily subjected to sharp conization to rule out stromal invasion before a decision is reached concerning definitive management. It is interesting to note that, of the 37 patients who had a panhysterectomy performed, 85 per cent showed marked stromal hyperplasia of the ovaries.

DISCUSSION

Since the cervix uteri and the upper one-third of the vagina are embryologically of muellerian origin, the mucosa might be expected to show some cyclical activity; and, indeed, there is no doubt that epithelial morphologic alterations do occur in response to exogenous or endogenous hormones. In normal response to estrogens the adult ectocervical epithelium shows hypertrophy and hyperplasia of the cells of the basal layer with rapid maturation toward cornification. Rosenthal and Hellman have shown that the cervical epithelium of stillborn, premature, and full term infants also responds to the maternal hormone milieu of

pregnancy. The endocervical glands of the infants became hyperplastic and were filled with secretion. Foci of squamous metaplasia or atypical hyperplasia reminiscent of carcinoma in situ were also noted. These same investigators have also studied the cervical changes in elderly patients and have again noted that atypical epithelial changes of the cervical epithelium do occur in menopausal or postmenopausal women with high endogenous estrogen levels or in women who have received high doses of exogenous estrogens. Many pathologists and clinicians have observed cases in which hyperactive lesions, some of which are quite atypical, first identified during pregnancy, subsequently disappeared in the puerperium. Thus, basal or reserve cell hyperactivity of cervical epithelium may be seen in a fetus, in elderly women, during pregnancy, in patients on intensive hormone therapy, and, as this work indicated, in patients with stromal hyperplasia of the ovaries. One of our postmenopausal patients known to have a primary breast cancer with widespread metastatic disease received large doses of estrogens. Investigation of uterine bleeding revealed the presence of carcinoma in situ in the cervical biopsy. There are several reports concerning animal experimental work in which atypical epithelial changes resembling human carcinoma in situ of the cervix were induced by hormone administration. On the other hand, Ritchie stated that in the experimental production of thousands of skin tumors in mice no carcinoma in situ was encountered. Likewise, Murphy produced squamous cell carcinomas in mice but encountered only a single papillary lesion that bore some resemblance to carcinoma in situ.

It seems unquestionable that certain cases of human carcinoma in situ can progress to an invasive carcinoma of the cervix. Kottmeier accepted 46 cases from the literature and added 12 of his own as examples of progression to invasive carcinoma. The interval varied from 10 months to 37 years and averaged 9 years. Of the thousands of cases of squamous cell carcinoma reported in the past half century, such a small number as 58 cases of carcinoma in situ with subsequent invasion requires that this concept should remain *sub judice*, as absolute proof of its nature has yet to be produced. Apparently not all of the wide range of epithelial lesions called carcinoma in situ in published reports will develop infiltrating cancers, and it is doubtful if enough is known of the fine correlation of structure and function to assume that all cervical carcinomas arise in zones of carcinoma in situ of the basal cell type. These atypical epithelial changes may indicate a genetically select group of patients who, because of abnormal tissue response to hormones and possibly other stimuli, have an increased susceptibility for the development of infiltrating carcinoma, particularly in times of maximum endocrine stress. Undoubtedly the trigger mechanism can arise from a wide variety of insults, only a few of which are readily discernible.

TABLE I.—BIOLOGIC CHARACTERISTICS OF CERVICAL LESIONS

Histologic diagnosis	*Endocervix (reserve cell)*	*Ectocervix (basal cell)*
Normal	Normal differentiation (to columnar cell) Complete maturation	Complete maturation
Squamous metaplasia	Abnormal differentiation (to squamous cell) Complete maturation	
Basal cell hyperactivity	Abnormal differentiation (to squamous cell) Delayed or irregular maturation	Delayed or irregular maturation
Carcinoma in situ, basal cell type	Failure in differentiation Failure in maturation (entire epithelial layer)	Failure in maturation (entire epithelial layer)
Prickle cell hyperplasia. (Bowenoid) (Variant)	Irregular differentiation Delayed or irregular maturation (at the prickle cell level)	Delayed or irregular maturation (at the prickle cell level)

The relationship of carcinoma in situ to infiltrating carcinoma of the cervix may be real; however, the true incidence, prevalence, and biologic nature of the disease can only be determined after exact histologic criteria for the diagnosis of carcinoma in situ are established. The use of the word "carcinoma" in describing these lesions is perhaps unfortunate, since few clinicians are willing to delay their surgical eradication for the purpose of correlating the precise histologic criteria employed in the diagnosis with the growth potential of the lesion. Several studies now in progress, in which groups of patients with proved carcinoma in situ are being followed closely without treatment, may shed light upon the vitally important question of the invasive potentialities of these cervical lesions.

SUMMARY

The cervical tissues from 42 acceptable cases of carcinoma in situ were subjected to careful histologic and cytochemical study. The purpose of this report is to seek specific histologic criteria for diagnosis, to search for a reliable method of identification of the basement membrane, and to attempt evaluation of the biologic characteristics of the lesion. The cervical tissues obtained from biopsy and hysterectomy specimens were stained with hematoxylin and eosin and periodic-acid-Schiff techniques. The latter stain was useful in identifying the basement membrane and therefore in determining objective invasion as well as in evaluating the degree of differentiation and maturation of cervical epithelium. It appears that carcinoma in situ of the ectocervix is a distinct entity characterized by atypical basal cell hyperplasia with a failure of cell maturation. When this lesion appears in the endocervix it results from reserve cell hyperplasia with absolute failure in differentiation as well as in maturation. Basal cell hyperactivity, atypical hyperplasias, and bizarre forms of squamous metaplasia can be readily differentiated from carcinoma in situ by determining the PAS stainability of the abnormal epithelium and by noting the degree and extent of cellular atypia. The cervices with typical areas of carcinoma in situ of the basal cell type, however, frequently showed variations in the morphologic and staining patterns in contiguous areas of cervical epithelium. These histologic variants commonly take the form of basal cell hyperactivity, or rarely, of atypical hyperplasia with delayed or irregular maturation in the midzonal layer. The latter lesion is predominantly prickle cell in type and appears in both the endocervical and ectocervical regions, recalling the lesions found in the skin and sometimes in the paralaryngeal mucosa commonly referred to as Bowen's disease. Until more is known of the fine correlation of structure and function, considerable effort should be exerted to establish precise and uniform histologic criteria for the diagnosis of carcinoma in situ. An attempt has been made in this report to describe the cellular changes and biologic characteristics of carcinoma in situ as well as other ectocervical and endocervical lesions with a view toward standardizing diagnostic criteria.

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INTRAPERITONEAL NEOMYCIN IN THE TREATMENT OF ACUTE BACTERIAL PERITONITIS

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RECENT REPORTS by Pridgen and Engel and Denson of respiratory arrest following the intraperitoneal administration of neomycin have focused attention on the advisability of using this technique. The experiences with a safe method of administering neomycin intraperitoneally are presented here to advance this method as an effective form of therapy.

Schatten and Abbott (9) demonstrated that intraperitoneally administered antibiotics are markedly effective in controlling experimentally produced acute bacterial peritonitis. The antibiotic concentration, they found, reaches very high levels in the peritoneal cavity. Surprisingly, the serum concentration reaches levels approximately the same as those obtained when the drug is given intravenously. Schatten (8) then showed that neomycin not only acts in this manner but is also a potent bactericidal agent with a wide spectrum and is relatively nonirritating to the peritoneal cavity.

Prigot and associates used a single dose of 1.0 gram of neomycin intraperitoneally as an adjunct to other antibiotics in the treatment of 21 postoperative patients with acute bacterial peritonitis. Schatten (8) reported the effectiveness of intraperitoneal neomycin (total amount of 2.0 to 3.0 grams in divided doses) as the only antibiotic used for 18 such patients. No deaths secondary to the peritoneal infection occurred in either series. In addition, Schatten and associates (10) administered neomycin intraperitoneally to 40 patients without peritonitis. No deleterious effects of the drug were noted in any of these 58 patients. In view of these findings, this form of therapy is now used frequently for patients with severe acute bacterial peritonitis admitted to the surgical service at the University Hospitals of Cleveland.

From the Department of Surgery, University Hospitals of Cleveland, Cleveland, Ohio.

METHOD

During the calendar year of 1956, on the general surgical service of this hospital 1,529 laparotomies were performed. Twenty of these patients had acute bacterial peritonitis sufficiently severe that the surgeon believed that the usual postoperative antibiotic therapy might not be adequate. They were therefore given neomycin intraperitoneally by Schatten's method of administration.

Two fine polyethylene catheters were inserted through the abdominal wall at the time of surgery by using a No. 13 needle as a trochar. The tip of one catheter was placed just superior to the site of the lesion, and the tip of the second was positioned in the pelvis ipsilaterally. Neomycin, 0.125 to 0.250 gram in saline, was injected into each catheter of every patient every 6 hours for 48 hours after surgery. All patients were given other antibiotics in addition. Eighteen received both penicillin and streptomycin in the usual doses, and 13, in addition, were treated with tetracycline or its derivatives. A few patients received up to 1.0 gram of neomycin in saline directly into the peritoneal cavity even before the incision was closed.

Six were private and 14 were staff patients. Their ages ranged from 5 to 91 years, with a median of 56 years. Thirteen were males; 7 were females. Nine had perforated appendices; 6 had perforations of other viscera; and 5 had other lesions (Table I).

TABLE I.—PRIMARY LESION FOUND ON LAPAROTOMY

Lesion	*No. of cases*
Perforated appendix	9
Perforated stomach	3
Ulcer	2
Reticulum cell sarcoma	1
Perforated cecum	1
Perforated diverticulum, colon	1
Perforated small bowel, traumatic	1
Mesenteric thrombosis	1
Acute suppurative ileitis	1
Empyema of gallbladder	1
Salpingitis with paratubal cyst	1
Subdiaphragmatic abscess after radical pancreaticoduodenectomy	1

RESULTS

No toxic effects of the drug were noted. Seven deaths occurred (mortality rate of 35 per cent), but 6 of these patients succumbed from causes other than peritonitis (Table II). The mortality from infection was therefore 7 per cent. The median hospital stay was 3 weeks. Sixteen patients suffered postoperative fever (temperature above 38 degrees C. beyond the first 3 hospital days). The longest febrile course lasted 34 days; the median was 9 days.

Fifty per cent of the survivors suffered from complications of the infection. Four had wound abscesses; 1 had a known pelvic abscess; and a second was suspected of having one; 1 abdominal wound dehisced. All patients responded well to appropriate therapy.

The original peritoneal culture in 3 patients showed no growth. Five patients had 1 bacterial species present, 8 had 2, and 4 had 3. The most common, the coli-aerogenes group, was present in 13 patients. Streptococcus viridans was found 7 times (Table III).

DISCUSSION

The mortality from all causes in 38 patients with peritonitis who received neomycin intraperitoneally at University Hospitals of Cleveland (Schatten's plus those presented here) was 18 per cent. There were no deaths among 21 similar patients at Harlem Hospital (Prigot's series). This figure appears to be quite low for patients with advanced bacterial peritonitis, but there is no control series with which it may be compared.

Nine patients in this series, 6 of Schatten's, and 4 of Prigot's, had perforated appendices. There were no deaths among these 19 patients. Green and Watkins found

TABLE II.—MORTALITY

Patient Age, yrs.	*Diagnosis, operation*	*Peritoneal culture*	*Remarks*
J.K. 64	Carcinoma, ampulla of Vater Incision and drainage of subdiaphragmatic abscess following radical pancreaticoduodenectomy	Proteus vulgaris, Escherichi coli, Staphylococcus aureus	1 yr. jaundice. 40 lb. weight loss. Marked debilitation. Pancreaticoduodenectomy followed by parotitis, frequent hypotension, psychosis. Dehiscence on 9th postop day. Subdiaphragmatic abscess found and drained. Intraperitoneal neomycin. Died on 4th day after closure, probably of overwhelming sepsis
G.C. 83	Perforated gastric ulcer. Plication of ulcer	Streptococcus viridans, Micrococcus tetragenes, Candida sp.	Died on 5th postop. day, probably of anoxia 2° to chronic pulmonary disease
P.F. 49	Perforated cecum. Closure of dehiscence	Escherichia coli, Streptococcus viridans	Perforated cecum 10 days after cerebrovascular accident. Appendectomy and cecostomy. Dehiscence on 5th postop. day. Intraperitoneal neomycin. Died 3rd day after closure, probably from the cerebrovascular accident
W.A. 58	Mesenteric thrombosis. Resection of ileum	Bacteroides sp.	Mesenteric thrombosis 1 week after right hemicolectomy for carcinoma. Ileum resected. Transfusion reaction followed by anuria. Died on 9th postop. day after dialysis with artificial kidney
E.S. 55	Perforated diverticulitis. Transverse colostomy	Microaerophilic streptococcus, Escherichia coli	Died within a few hours of surgery with pulmonary edema
R.M. 49	Perforated stomach. Plication of perforation	(None)	Reticulum cell sarcoma found on laparotomy. Diffuse metastases. Died following reperforation of stomach on 12th postop. day
O.E. 56	Perforated ileum. Suture of ileum	Escherichia coli	Hypothyroid; hypertensive cardiovascular disease. Severe congestive failure. Bowel perforated during paracentesis. Laparotomy 24 hours later. Irreversible shock on 2nd postop. day felt to be cardiac in origin. Died on 6th postop. day

a mortality rate of 18.7 per cent for appendicitis with perforation in the preantibiotic and early antibiotic eras (1930 to 1941). It should be noted that the difference in mortality is not statistically significant, even if all of the improvement was the result of the neomycin (and this is not likely). A much larger series of patients treated with intraperitoneal neomycin will be needed before the value of this form of therapy can be proved or disapproved. Until this has been accomplished, it can only be stated that the mortality rate of those patients who were treated in this manner is encouragingly low.

The patients in this series did not show any obvious decrease in the frequency of complications, postoperative fever, or duration of hospital stay. Although the only complication reported by Prigot was one of dehiscence, Schatten's patients suffered 4 wound and 3 pelvic abscesses. The apparent inability of intraperitoneally administered neomycin appreciably to alter the frequency of these complications is understandable. Therapeutic levels are probably not obtained in the wound or in isolated, infected regions of the peritoneal cavity. Its value seems to lie in its ability to prevent a fatal peritonitis.

Carr, Brown, and Pfuetze, Kadison and associates, and Powell and Hooker reported that 8 patients suffered a hearing loss and 10 patients renal function changes from among at least 38 patients who received parenteral neomycin for from 2½ to 6 weeks. It is not surprising, then, that neither ototoxicity nor nephrotoxicity has been found following a short, 2 day course of intraperitoneal neomycin.

Pridgen and Engel and Denson reported a total of 8 cases of respiratory arrest following the administration of intraperitoneal neomycin. All 8 cases had one thing in common: the dose injected into the peritoneal cavity at one time exceeded the dose of 0.5 gram recommended by the manufacturer. The 2 adults studied in their series received 3.0 grams intraperitoneally at one time; 5 infants received a single dose of 0.5 to 1.0 gram of neomycin (equivalent to from 3 to 15 grams in a 70 kilogram adult), and a sixth infant received an "unknown" dose. A single large dose of neomycin may very well produce respiratory arrest, but there is no reason to believe that the small divided doses discussed in this study (0.250 to 0.500 gram every 6 hours) will have any deleterious effect upon the patient. The dose of the drug administered to children and debilitated patients should be decreased proportionately.

TABLE III.—BACTERIA FOUND ON INITIAL PERITONEAL CULTURE

Genus	*No. of cases*
Escherichia-Aerobacter group	13
Streptococcus (viridans)	7
Streptococcus (anaerobic)	3
Bacteroides	3
Proteus	2
Staphylococcus	1
Bacillus (subtilis)	1
Pseudomonas	1
Candida	1
Micrococcus tetragenes	1
No growth	3

SUMMARY AND CONCLUSION

Twenty patients with severe, acute bacterial peritonitis were treated with divided doses of neomycin, administered intraperitoneally, in addition to parenteral therapy with other antibiotics. No deleterious effects of this form of therapy were noted. The mortality from infection was 7 per cent. The incidence of complications of the infection was 50 per cent. Intraperitoneal neomycin appears to lower the mortality rate in this group of patients, but does not seem to change the morbidity rate. Recent reports associating intraperitoneally administered neomycin with respiratory arrest have in common the employment of massive doses of the drug.

In view of the innocuousness of this form of therapy and of the low mortality rate from infection, neomycin administered intraperitoneally in moderate-sized, divided doses is recommended as an adjunct to surgery for patients with severe acute bacterial peritonitis.

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THE HAZARDS OF RURAL LIVING

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ON AUGUST 31, 1942, John Kerbs, then 15 years of age, son of Mrs. Maximillian Kerbs, was preparing for his departure for home from a camp on Lake Champlain where he had spent the summer. In the cabin with him were 2 companions and an "unloaded" gun. The "unloaded" gun, with a defective firing mechanism, was aimed at John and discharged, the blast blowing out the anterolateral aspect of his right thigh and severing the femoral artery. The presence of 2 young ladies in an adjacent cabin saved his life. One stuffed soiled bath towels into the wound; the other ran to the nearest telephone to call an ambulance.

Mrs. Kerbs sent me the following account of subsequent events. "The old hospital notified Dr. Leon E. Sample who was attending a dinner in honor of his birthday. Dr. Sample left the party immediately and met John at the hospital. En route the ambulance driver picked up on the street a man to act as a donor. There was no time to type either his blood or that of my son and the nurses paced the floor outside the emergency room, praying. Dr. Sample never left the hospital and seldom left John's side for 48 hours. John was at death's door for 2 weeks. Finally gangrene set in and Dr. Sample said that John's leg must be removed to save his life."

According to the St. Albans Daily Messenger "the operation which altered the lives not only of the victim and the principals of the tragedy, but of everyone in Franklin County, Vermont, was a success. John rallied and to-day is leading a very normal life. His mother, fully conscious of what had been accomplished by Dr. Sample, displayed her overwhelming gratitude in subsequent months by donating a large sum of money toward the construction of a new hospital."

In a letter to me dated April 1 of this year Dr. Sample writes with what I am sure is characteristic modesty "It was an ordinary run of the mill amputation following trauma and my own part in it, as the surgeon involved, represented nothing unusual. The boy was cared for in an old unsafe hospital here and Mrs. Kerbs made it possible for us to have a completely new one which opened in 1950."

And so was erected in the little village of St. Albans, Vermont, the Kerbs Memorial Hospital, a modern institution, fully and completely equipped, dedicated to the people of Franklin County in memory of Edward A. Kerbs by Alice H. and Jeanne E. Kerbs, in gratitude for the professional skill of Dr. Leon E. Sample and his associates.

Not only accidentally shot, as was John Kerbs, but shot and killed by all manner of explosives in the United States in 1955 were 2,200 persons; 14,200 were killed while at work; 28,000 met death accidentally while "safe at home"; and 38,300 were killed by motor vehicles (1). The grand total of accidental deaths in the United States in 1955 was 93,000 and this figure is expected to be higher when analysis of the data for 1956 has been completed.

Throughout the land accidents are responsible for twice as many deaths between the ages of 1 and 25 years as are the 2 most fatal diseases during these years (Table I); pneumonia and congenital malformations from the age of 1 to 4 years, cancer and congenital malformations between the ages of 5 and 14 years, cancer and cardiac disease between the ages 15 and 24 years. During the next 20 years of life accidents are

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The second Leon E. Sample Lecture, Columbia-Presbyterian Medical Center, New York, May 2, 1957.

TABLE I.—LEADING CAUSES OF DEATH IN THE UNITED STATES AMONG BOTH SEXES FROM AGE 1 THROUGH 44 YEARS

Ages, yrs.	*Causes*	*Death rate*
1–4	Accidents	34
	Pneumonia	15
	Congenital malformations	12
5–14	Accidents	20
	Cancer	7
	Congenital malformations	3
15–24	Accidents	56
	Cancer	9
	Heart disease	5
25–44	Heart disease	46
	Accidents	43
	Cancer	40

superseded only by cardiac disease as the leading cause of death in the United States.

Among all persons under 65 years of age, motor vehicles are responsible for more deaths than is any other type of accident. In 1956 fatalities from this cause alone numbered 40,200, an increase of 5 per cent over the previous year, and estimates by the National Safety Council suggest that "the worst is yet to come . . . that the year 1966 can be expected to produce in access of 53,000 fatalities" from motor vehicles (4). Furthermore, for every person killed, 100 more are injured, some only seriously enough to lose 1 day from work, others so extensively that they are totally disabled for the remainder of their lives.

Truly this is a massacre beyond precedent in an allegedly civilized age, a problem of prodigious proportions in which the members of the medical profession must interest themselves if this appalling epidemic of accidents is to be curtailed. Around the clock every day of every week throughout the year, 1 accidental death occurs every 6 minutes and 1 injury every 3 seconds.

TABLE II.—TABULATION OF DATA ON TWO SERIES OF RURAL ACCIDENTS AVAILABLE FOR STUDY

All rural accidents	*1946–1950*	*1931–1935*
Automobile	283	233
Home	274	91
Farm	232	113
Occupational	112	68
Miscellaneous	108	95
Sporting	81	89
	1090	689
Total	1779	

And rural accidents far outnumber in severity those which occur in larger urban areas. New York City, with 53 per cent of the population of the State, is responsible for 40 per cent of the fatal accidents; cities of over 10,000, with 23 per cent of the population, contribute 18 per cent of the accidental deaths, exactly the same proportion as in the metropolitan area; towns and villages of less than 10,000, which comprise only 24 per cent of the total population are responsible for 40 per cent of the fatal accidents. In other words, the rural areas of the State, though comprising only one-fourth the total population, contribute over one-half the fatal accidents, making the incidence of accidental fatalities in the country more than twice that in metropolitan areas, and in all other cities of 10,000 population and over.

The members of the surgical staff of the Mary Imogene Bassett Hospital in Cooperstown are in a particularly favorable position for the study of rural accidents of all types. The village is situated in the eastern central part of the State 10 miles south of the U. S. Route 20, a transcontinental highway from Boston and New York through Albany, Buffalo, Cleveland, and Chicago, to points west. The hospital serves an area 50 miles in length along this highway and most of the persons seriously injured on this section of Route 20 are referred there for treatment. Within the village itself are the Baseball Museum and Hall of Fame, the Farmer's Museum, and the New York State Historical Association which attract 200,000 visitors annually. Furthermore, Cooperstown is in the center of the dairy farming industry and more recently truck farming has become an important source of income. Small farms are numerous and farming is often an occupation of necessity rather than choice.

ALL RURAL ACCIDENTS

Available for study (Table II) are two series of rural accidents of all types, each group embracing a period of 5 years. The chronologically later group includes all patients admitted to the hospital because of

trauma during the years 1946 to 1950; the earlier series covers the half decade 1931 to 1935 and was first reviewed for a Conference on Rural Medicine held in Cooperstown in 1933 (3). For comparative analysis these two groups of patients and the accidents by which they were injured are often considered separately; together they permit statistical study as a series of 1,779 patients. Also available for review are 712 patients injured in 492 automobile accidents during the years 1930 to 1939 and a total of 658 agricultural injuries in 2 decades of farm accidents, 310 during the years 1929 to 1938 and 348 from 1939 to 1948. Both the motor vehicle and the farm accidents have been reported previously (2, 6–8) but are again presented in order to re-emphasize the hazards of rural highways and the dangers of rural living.

Seasonal distribution. The incidence of all rural accidents rises rapidly during the summer months to a peak in July and August and then falls abruptly with the departure of tripping tourists from the rural highways, the completion of the harvest, and the return of children to school. The curves representing the seasonal distribution of these two groups of rural accidents due to all causes, though separated by a span of 15 years, are similar in every detail (Fig. 1). Many of these summer accidents occur during the first decade of life when urban children are turned loose on grandfather's farm during the long vacation to roam and play at will among hazards of which they are totally ignorant, farm animals, farm vehicles, farm machinery, and farm buildings. The congestion on rural highways and the increased incidence of motor vehicle accidents in July and August also contribute in large measure to the seasonal summer peak.

Age distribution. The six-fold increase in the frequency of accidents during the first 5 years of life since 1930 is very impressive (Fig. 2) and cannot be explained by a corresponding increase in the number of infants and children in Otsego County during the past 20 years. In 1930, 7.3 per cent of

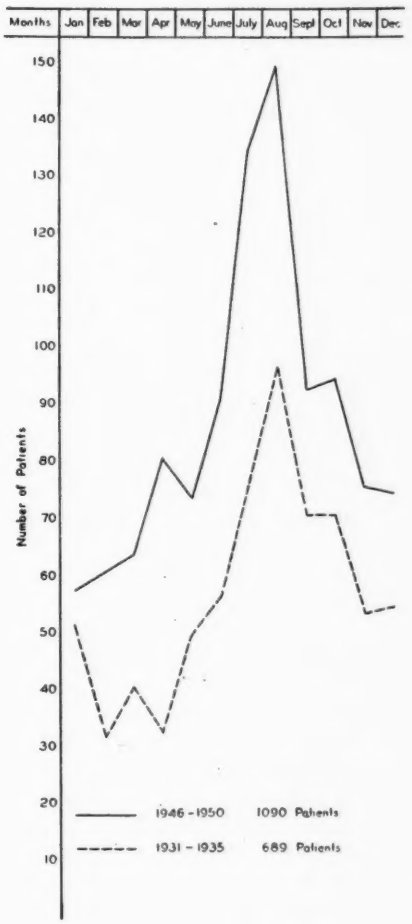

FIG. 1. Curves representing the seasonal distribution of two series of rural accidents, 1931 to 1935 and 1946 to 1950.

the population were under 5 years of age; in 1950 the proportion had risen to 10 per cent only. Hence, the explanation must be found elsewhere.

As indicated in a previous article (9), falls are responsible for most accidents during these years; however, many children are injured while riding in automobiles and others are struck by moving cars while walking or riding their bicycles across village streets or along rural highways. Fire and hot

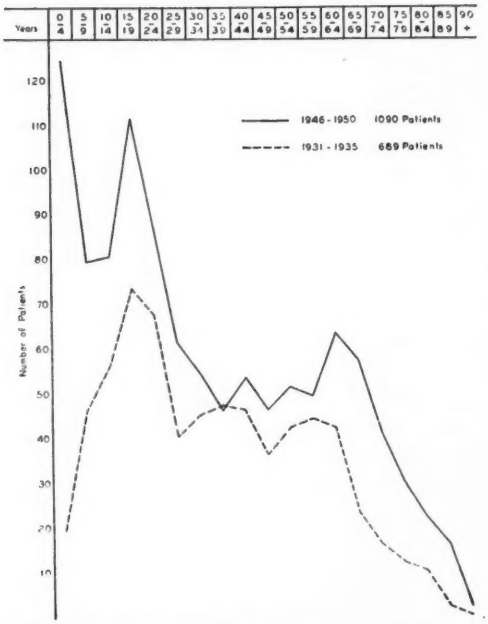

FIG. 2. Graphic representation of the age distribution of all patients injured in these two groups of rural accidents.

water, flames and the matches which produce them, burning leaves, brush fires, and bonfires all have a great attraction for children and often leave them dead or permanently injured. Pennies, peanuts, marbles and buttons, kerosene, gasoline, cleaning fluid, and furniture polish find their way to the tracheobronchial tree, esophagus, and stomach, and, if not promptly fatal, lead to serious complications. The newest offending agent of this type is sugar-coated aspirin which has recently been responsible for 23 cases of poisoning during the first 5 years of life. And finally, all the electric and other mechanical gadgets so universal in the homes of today were much less common 2 decades ago and are currently responsible for many injuries in infancy and childhood.

TABLE III.—MOTIVATING ACTIVITIES RESPONSIBLE FOR 1,779 RURAL ACCIDENTS

Activities	*Patients*	
	No.	*Per cent*
Motoring	516	29.0
Domestic activities	365	20.5
Farming	345	19.4
Other occupations	180	10.1
Sports	170	9.6
Miscellaneous activities	203	11.4
Total	1779	100.0

Subsequent to the first half decade of life, accidents are most common between the ages of 15 and 19 years (Fig. 2) after which a sustained lower level is maintained from the beginning of the fourth to the middle of the eighth decades; thereafter the incidence falls abruptly. Except for the discrepancy during the first 5 years of life the two curves are remarkably similar.

Males are injured with twice the frequency of females.

Accidents at home are most common during the first and after the sixth decade; motor vehicle accidents, during the late teens and early twenties; and many hazards beset the farmer and his family throughout their lives (Fig. 3). Other occupational accidents, as one would suspect, are most common from the beginning of the third through the seventh decade (Fig. 4). Accidents secondary to participation in sports reach a peak during the second decade of life and those due to miscellaneous activities are most common during the first, second, and after the fifth decade. These latter are due largely to injuries sustained on school playgrounds and falls in public buildings or on the street.

Motivating activities. Two factors participate in the causation of all accidents, a motivating activity and an etiologic agent. Motoring was responsible for nearly one-third of these 1,779 rural accidents, domestic life and farming each for one-fifth. Other occupations, sports, and miscellaneous activities accounted for approximately one-tenth each (Table III).

Etiologic agents. Falls on the same level or from one level to another are responsible for most fatal accidents in all reported series; within this group, for 35.4 per cent of all accidents, both fatal and nonfatal (Table IV). Motor vehicles were the etiologic agents in approximately one-third of the accidents. Cutting or piercing instruments,

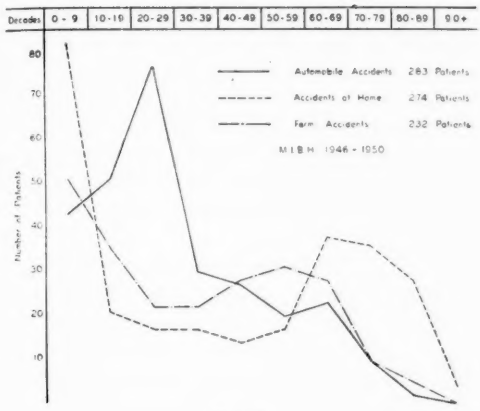

FIG. 3.

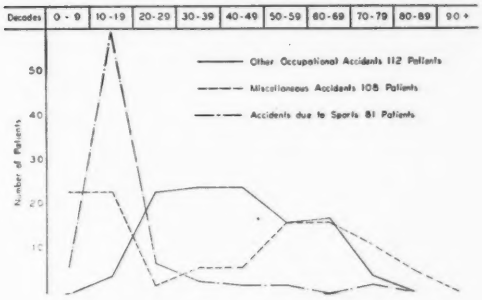

FIG. 4.

FIG. 3. Age distribution of patients injured at home, by motor vehicles, and on the farm.

FIG. 4. Age distribution of patients involved in other occupational accidents, accidents due to sports, and in accidents resulting from miscellaneous activities.

including broken glass, rusty nails, and splinters, often with serious secondary infection, were the offending agents in 13 per cent; animals, excessive heat or cold, crushing instruments or machines, and falling bodies were individually responsible in approximately 3 to 4 per cent, firearms for 1.3 per cent. Bites by animals, both wild and domestic, may be particularly dangerous in an area where rabies is endemic as it has been in the central part of New York State during the past decade.

Allocation of responsibility for accident. At least 70 per cent of all accidents are due to carelessness, either of the person injured or of some companion; allocation of the responsibility, however, is frequently difficult. So far as could be determined from a review of the hospital records of these 1,090 patients in the later series, 40 per cent were due to carelessness of the patient and 26 per cent to carelessness by someone other than the injured person. Twenty-three per cent were the result of the unpredictable behavior of animals, machines, or motor vehicles, or transpired during participation in sports; in 11 per cent of the accidents the responsibility for the mishap could not be determined.

Certain individuals are prone to sustain accidents and others are not. An evaluation of "accident proneness" is difficult to assess without involved psychiatric study of the patient, and often of his family as well, and is definitely beyond both the scope of this review and the ability of the writer. "Repeaters" were common, however, in both groups; approximately 25 per cent of the patients had one or more previous or subsequent accidents of greater or lesser severity, and several were killed in later accidents.

Treatment before arrival at the hospital. In spite of the serious nature of many of these injuries, half the patients received no treatment whatever before arrival at the hospital. Although many had been seen by local physicians en route fractures had not been splinted, wounds and burns had not been dressed, and neither sedatives nor antibiotics had been administered. About 20 per cent of the patients were given first aid by physicians or laymen, often more efficiently and effectively by the latter than by the

TABLE IV.—ETIOLOGIC AGENTS IN 1,779 RURAL ACCIDENTS

Agents	*Patients*	
	No.	*Per cent*
Falls	631	35.4
Motor vehicles	516	29.0
Cutting or piercing instruments	229	12.9
Animals	73	4.1
Excessive heat or cold	71	4.0
Crushing instruments or machines	54	3.0
Falling bodies	49	2.8
Firearms	24	1.3
Others	122	6.9
Unknown	10	0.6
Total	1779	100.0

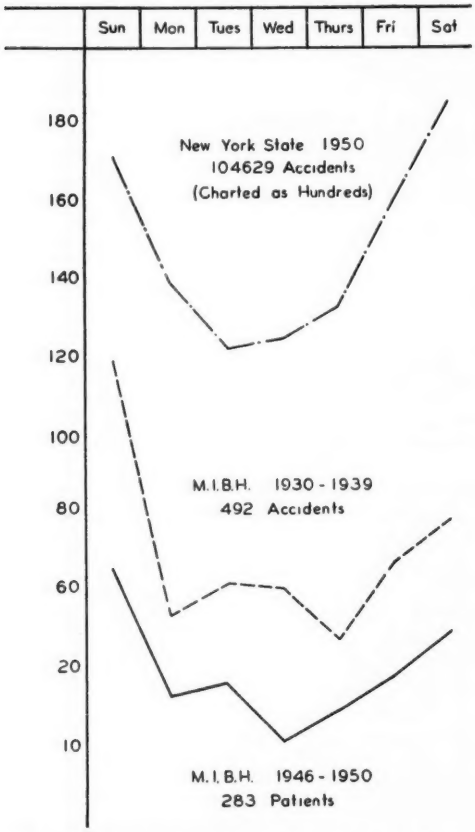

FIG. 5. Weekly distribution of automobile accidents in New York State in 1950 compared with the two series studied at the Bassett Hospital in 1930 to 1939 and 1946 to 1950.

former. Thirty per cent only received definitive treatment before admission, half of these by the ambulance intern and the remainder by general practitioners or in the accident room of other hospitals.

Duration of hospitalization. During the years 1931 to 1935 the average period of hospitalization was 18.6 days and the average number of visits to the out-patient department following discharge was 5.2 per patient. Fifteen years later, subsequent to the institution of early postoperative and posttraumatic activity, the average length of time spent in the hospital by each patient was 9.6 days and the average number of out-patient visits was 3.3. This represents a saving of 50 per cent in hospital days and nearly the same in number of out-patient visits.

Prepayment plans for medical care have not been widely accepted by farmers and their families in central New York and often a serious accident is a major financial catastrophe.

Mortality. Twenty-one of the 689 patients in the early group died, a mortality of 3 per cent. Five were moribund on arrival at the hospital and lived only a few hours; the remainder survived from 2 days to 3 months. Terminal bronchopneumonia was the chief cause of late death in elderly patients.

Fifteen of the 1,090 patients in the later series failed to survive, a mortality of 1.3 per cent, or about half that of the first group. Responsible for this improvement in mortality rate are the more ready availability of blood and substitutes therefor, the extensive use of chemotherapeutic agents and antibiotics, the utilization of anticoagulants for the prevention and treatment of thrombosis, improved methods for internal fixation of fractures allowing early mobilization and ambulation after injury, a better understanding of the problems and treatment of electrolyte imbalance secondary to severe trauma, and advances in the science of anesthesiology.

AUTOMOBILE ACCIDENTS

The first fatal motor-vehicle accident occurred in New York City in September 1899. Mr. H. H. Bliss stepped off a trolley car; a passing automobile struck him; a doctor on the scene gave first aid but Mr. Bliss died in the Roosevelt Hospital the following day. During the subsequent 50 years motor vehicles have claimed the lives of 1,000,000 Americans, and if the present rate continues, the second million will be killed in another 25 years. One out of 2 persons now living has been, or will be injured in a motor vehicle accident during his life, or prematurely killed in the same way. These facts are all the more significant

when one considers that only a few over 500,000 soldiers have been killed in action in all the wars in which this nation has been engaged.

In 1940 a survey (7) was published of 492 rural accidents due to motor vehicles as the result of which 712 patients were admitted to the Bassett Hospital during the years 1930 to 1939.

Seasonal, weekly, and daily distribution. The seasonal distribution of such accidents parallels closely the seasonal distribution of all rural accidents, reaches a peak during July and August (7) and then subsides with the disappearance of touring Americans from the highways. August is without question the most dangerous month of the year on the open road. Not only do more accidents occur during this month but more persons are injured per accident. In February and March, when the roads and the weather are worse than at any other time of the year in central New York, accidents due to motor vehicles are least frequent.

The weekend is extremely hazardous. And the same is true throughout New York State. In Figure 5 is charted (in hundreds) the weekly distribution of 104,629 motor vehicle accidents which occurred in New York State in 1950 compared with the 492 accidents in the Bassett series of 1930 to 1939 and with the 283 patients injured in highway accidents during the years 1946 to 1950.

Throughout the State, accidents were a little more frequent on Saturday, possibly because so many people leave urban homes and jobs for weekends in the country at about the same time. Sunday is a more dangerous day on the highways of Otsego County.

Of equal, or even more, importance is the distribution of such accidents around the clock. The hours of late afternoon and early evening are by far the most dangerous on the rural highways of central New York (7) and also on the congested turnpikes and broad avenues of urban areas throughout the State (Fig. 6). Traffic is heaviest at the end of the day, drivers and pedestrians both are weary and both are anxious to reach

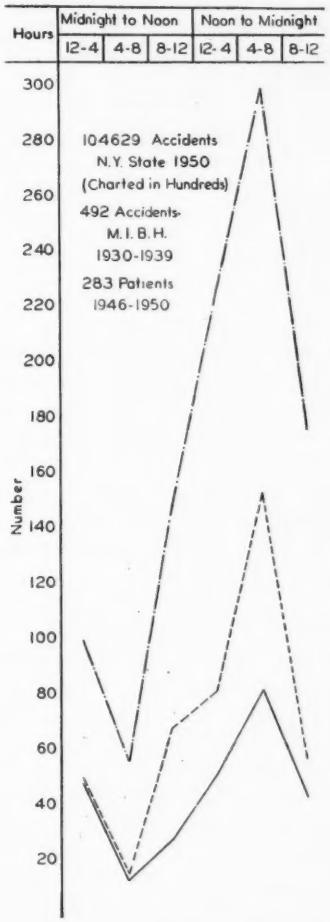

FIG. 6. Daily distribution of automobile accidents in New York State in 1950 compared with the two series studied at the Bassett Hospital in 1930–1939 and 1946–1950.

their destinations; excessive speed by the former and undue callousness by the latter are common, and death truly stalks the highways between these hours.

Conditions of travel. The vehicles most frequently involved are passenger cars, your car and mine, while travelling straight ahead, on dry roads, in clear weather, during the hours of daylight. The tabulation of Table V leaves little doubt about these assertions relating to accidents as they occur

TABLE V.—TABULATION OF DATA RELATIVE TO CONDITIONS OF TRAVEL AND TYPES OF VEHICLES MOST FREQUENTLY INVOLVED IN RURAL ACCIDENTS, 1930 TO 1939, AND IN ALL MOTOR ACCIDENTS IN NEW YORK STATE, 1950

	Per cent of all accidents	
Conditions	*M.I.B.H. 1930–1939*	*N. Y. State 1950*
Passenger cars	84.7	79.0
Forward motion	75.7	66.1
Dry roads	63.4	55.5
Clear weather	69.3	69.3
Daylight	60.5	59.2

both in central New York and throughout the State.

Analysis of injuries. In the rural area embraced by this study both sexes are involved in automobile accidents very much more frequently between the ages of 15 and 24 years than during any other decade of life(7). Males are injured twice as often as females. The same age distribution among the victims of *fatal* motor vehicle accidents has been reported by the Metropolitan Life Insurance Company; the death rate is highest among males at age 21 and females at 18.

The 712 patients admitted to the Hospital because of these 492 accidents sustained 2,891 recorded injuries, an average of 4 per patient. And many received multiple injuries of bones and soft parts in combination. There were 655 fractures of which 74 were compound; lacerations, contusions, and abrasions were next in order of frequency (7). One hundred eighty-four patients sustained concussion of the brain and 104 were in shock upon arrival at the hospital. The head and neck are most susceptible to trauma in automobile accidents and were injured with twice the frequency of any other part of the body (Fig. 7). Traumatic lesions of the shoulder and upper extremity and the hip and lower extremity were comparable to one another in numbers but less than half as common as injuries of the head and neck.

Thirty-five accidents were fatal. Twelve persons were killed immediately or died at the scene of the accident before the ambulance arrived; 7 were moribund upon admission and survived for an average period of 35 minutes; with 1 exception the duration of life in the remaining 15 fatal cases was approximately 6 days. The accident mortality rate was 7 per cent; the patient mortality, 5 per cent.

Excessive speed, callous driving, lack of acquaintance with the hazards of the open road, fatigue, and alcohol were responsible for most of the accidents in this series.

This country is currently involved in no war, yet the death of its young men and women continues at an appalling rate on the highways of the nation.

TABLE VI.—TABULATION OF FATAL ACCIDENTS IN MAJOR INDUSTRIES IN THE UNITED STATES, 1940 TO 1955

	Fatal accidents			
Industries	*1940*	*1945*	*1950*	*1955*
Agriculture	4500	4500	4300	3700
Trades and service	3700	3100	3700	3700
Construction	3100	1700	2300	2400
Manufacturing	2000	2700	2600	2100
Transportation and public utilities	1900	2500	1600	1500
Mining, quarrying, gas, and oil wells	1500	1400	1000	800
Total	16700	15900	15500	14200

FARM ACCIDENTS

Farming is the most dangerous occupation by which man earns his bread and, until 1955, agriculture was annually responsible for more occupational deaths than any other major industry (Table VI). However, when considered in relation to the death rate per 100,000 workers, agriculture is currently in third position (Table VII).

By recognition of the inherent dangers to which workers in other occupations are daily exposed and by the institution and enforcement of measures to promote safety, both by management and by labor, other industrial death rates are steadily falling (Table VII). Significant improvement has occurred even during the past 10 years. Between 1945 and 1955 the rate for miners and allied workers has dropped from 187 to 104 per 100,000 employees; the rates for construction and transportation have fallen from 126 to 76 and from 68 to 44, respectively. On the contrary, the occupational death rate among workers

on farms was actually higher in 1955 than it was 10 years previously.

Furthermore, fatal accidents form only a small proportion of the total. In a comprehensive survey made by the Department of Agriculture covering 3,000 odd counties in the United States in 1948 (10) the following estimation for the first 4 months for that year was given.

"Over a quarter of a million people who were living or working on farms were injured seriously enough to lose at least one day's time from their regular activities. The cost of medical, dental, and hospital care exceeded $11,000,000 and the total time lost was over 6,000,000 days, including no allowance for time lost by persons who were fatally injured or permanently and totally disabled."

And this concerned 4 months of the year when farm accidents are very much less numerous than they are during the summer and autumn! Twenty million working days per year is the minimal estimate of the amount of time lost to agriculture as the result of farm accidents (8).

Seasonal distribution. Agricultural accidents follow the same seasonal pattern as do all other rural accidents (2). The peaks during July and August are composed largely of accidents due to haying, those which occur during the repair and construction of buildings, and those in which children are injured while at play around machinery in operation, men at work, farm animals, and farm buildings.

Location. During the years 1929 to 1938 the barn and barnyard were found to be the most dangerous areas on the farm (2). Accidents in the pastures, fields, and hayfields were next in order of frequency but still less than half as common as those in the barn and barnyard. Seven per cent of the accidents occurred in the farmhouse and shed. The "highway accidents" did not represent mishaps to farmers riding in motor vehicles for pleasure but were limited to those which took place on the highway during hours of work with animals or farm machinery. The close correlation of the frequency with which farm accidents occurred in the same localities during the second decade, 1939 to 1948, is striking. The first group was analyzed by me (2) and the second by Calandruccio without collaboration during the actual perusal of the hospital records and tabulation of the data.

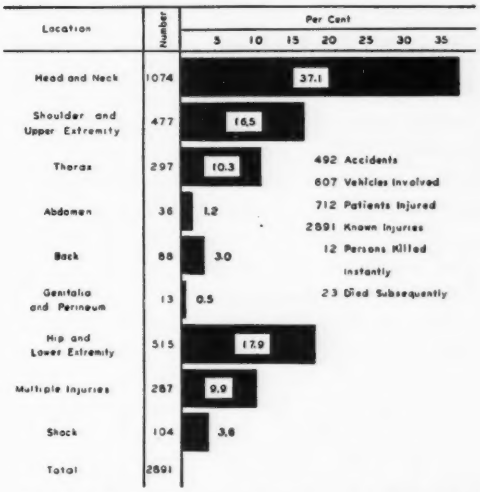

FIG. 7. Tabular summary of number and distribution of injuries sustained by 712 patients involved in 492 rural motor vehicle accidents.

Etiology. Accidents occurring during the performance of routine farm chores are most common and maintain a fairly constant frequency throughout the 12 months. Falls with no specific agent involved are responsible for the major proportion of all farm accidents throughout the country. In this dairy farming area of central New York injuries caused by farm animals (8) were next in order of frequency; three-fourths of these were produced by horses and one-fourth by

TABLE VII.—OCCUPATIONAL DEATH RATE IN MAJOR INDUSTRIES, 1945 TO 1955

	Deaths per 100,000 workers		
Industries	*1945*	*1950*	*1955*
Mining, quarrying, gas, and oil wells	187	110	104
Construction	126	93	76
Transportation and public utilities	68	43	44
Agriculture	53	57	55
Average, all industries	31	27	24

cows and bulls. Tools, scythes, axes, pitchforks, manure forks, and other implements were responsible for one-sixth of the injuries. Machinery, of which rotary saws, ensilage cutters, and mowing machines are by far the most mutilating, was the specific agent in 12 per cent of the accidents. Farm vehicles were next in order of frequency. However, in the great agricultural areas of the midwestern and north central sections of the United States, where mechanized farming has been extensively developed, machines rank second among the leading causes of accidents. In these areas 28 per cent of the accidents due to machinery are associated with tractors and 9 per cent with combines and threshing machines. In the far west and south, animals assume second place as they do among the dairy farming communities of central New York.

Classification of injuries. Among the 1,527 recorded injuries sustained by the 658 patients included in this survey were 488 fractures of which 134, or 27.4 per cent, were compound. Lacerations were next in frequency (2). Divisions of tendons, nerves, and blood vessels, partial or complete amputations of fingers, hands, forearms, and legs were common. Puncture wounds were less frequent but were often complicated by extensive and serious infections.

Many patients received multiple lesions of bones and soft parts in combination. The upper extremities sustained 50 per cent more total injuries than the lower; fractures alone, however, occurred with equal frequency in both. The head and neck are injured much less frequently in farm accidents than they are in accidents due to motor vehicles.

Analysis of fatalities. During the years 1929 to 1938 there were 16 deaths among 310 patients admitted to the hospital because of occupational injuries sustained in farming. During 1939 to 1948 there were 3 deaths among 348 patients with injuries of comparable severity. Two of these were moribund on admission and the third succumbed to massive pulmonary embolism. Five of the fatal accidents in the first decade and 2 in the second occurred during the performance of routine chores. Farm animals were responsible for one-fifth of the fatal accidents in the first group and for all 3 in the second. The mortality rate for those injured during the first decade was 5.1 per cent; during the second decade 0.8 per cent.

CONCLUSION

The infants, children, youths, and young adults of America are being decimated by accidents on the highway, in the home, and on the farm.

Motor vehicles are responsible for more deaths (among all persons under 65 years of age) than is any other type of accident. Thousands of others are killed annually while "safe at home." Farming is responsible for more occupational deaths each year than is any other major industry.

And the proportion of *fatal* accidents is far greater in rural areas than in cities and large metropolitan centers.

If this appalling massacre, this tragic and needless loss of life and limb, is to be curtailed, the members of the medical profession must interest themselves in the prevention of accidents which are now responsible for the death of 100,000 persons annually in the United States.

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THE ANATOMY OF COLLATERAL CIRCULATION

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THE ESSAYIST plans to bring angiographic and clinical evidence to bear on our concepts of the morphology and effectiveness of various collateral systems. Our knowledge of the compensation for obstruction in various parts of the arterial or venous systems has been, in the past, largely morphologic; that is to say, we have assumed that neighboring vessels will serve as collaterals in most regions. Even this simple approach has not been adequately exploited. Thus, for example, a limb is often treated as one homogenous mass of tissue, whereas its parts exhibit varying degrees of vascular circumscription. As another example, it has been assumed that the epigastric arteries, which comprise an important collateral pathway in coarctation of the aorta, are significant also in arteriosclerotic occlusion of the aorta; but recent study indicates this is rarely, if ever, so. In the liver, lungs, and heart, collateral flow may be established between vessels differing in the pressure or chemical content of the blood which they carry. The proposal is made that the term "supplementary" be applied to such vascular connections.

It is evident that various collateral systems vary considerably in adequacy, ranging from total inadequacy with death of the part, to relative adequacy under some clinical conditions, and finally to complete restoration of circulatory function. It is noteworthy that in the case of at least one paired organ—the kidney—death of one member of the pair is preferable to its viability with inadequate circulation, so far as the organism as a whole is concerned, since renal arterial insufficiency gives rise to life-threatening hypertension, and venous insufficiency engenders a nephrosis.

In general, considerations relating to the arteries apply equally to the veins, but certain peculiarities of venous collaterals will be noted.

DEFINITIONS

Parts of the collateral path. It may be reaffirmed that a collateral path is one which bridges an obstruction in a vascular trunk. Only rarely, as in the case of an arteria aberrans of the brachial artery, or of a segment of the circle of Willis, is a single large channel available as the by-passing vessel. Usually the path consists of a vessel or vessels coursing parallel to the trunk, meeting and discharging blood into a vessel which has branched from the trunk below the obstruction and has run proximally, in a recurrent direction. The proximal half of this pathway may be called the "affluent" of the anastomosis, and the recurrent or distal half, the "effluent" (Fig. 1). When obstruction occurs at two or more levels, the blood of the effluent vessels must be discharged across a secondary, or even tertiary, set of anastomoses. The size of the anastomotic connection at the junction of affluent and effluent is of great significance since, according to the law of Poiseuille, the quantity of flow through a vessel is proportionate to the fourth power of its radius. This is shown experimentally in a previous article of the author (11). Thus an inosculation of two sizable vessels allows a much greater flow than a reticulate anastomosis effected by the junction of fine branching of affluent and effluent.

Whether or not a particular artery will function as a collateral must be determined by experimental and clinical evidence, but it is reasonable to consider as potential collaterals vessels which course proximally and

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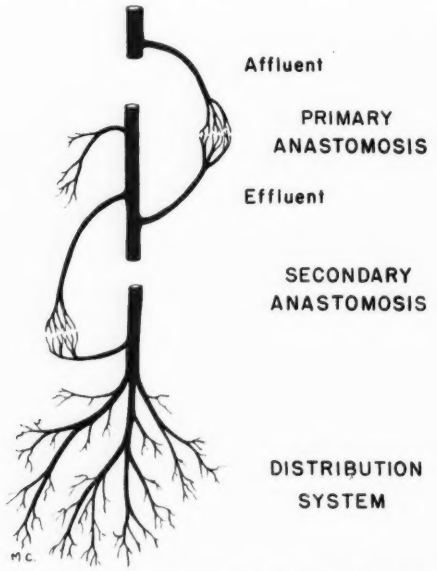


FIG. 1. Distinction between collateral and distribution systems, and identity of parts of an anastomosis.

distally, parallel to the obstructed trunk. Contrariwise, vessels coursing in a relatively transverse direction with respect to the involved artery will hardly be available as collaterals, except by the relatively ineffective anastomosis of their finest branches. The brachial and popliteal arteries are good examples of the extremes of this availability, the numerous longitudinally directed branches of the brachial contrasting with the meager and transverse branching of the popliteal. This is in keeping with the difference in effect of interruption of these two arteries. Thus DeBakey and Simeone, reporting on the acute effects of war wounds, found that interruption of the brachial artery was followed by gangrene in 26 per cent and of the popliteal in 73 per cent. The popliteal is also substantially more crucial than the femoral artery, whose interruption caused loss of the limb in 53 per cent; probably because of the paucity of longitudinally directed branches at the level of the knee.

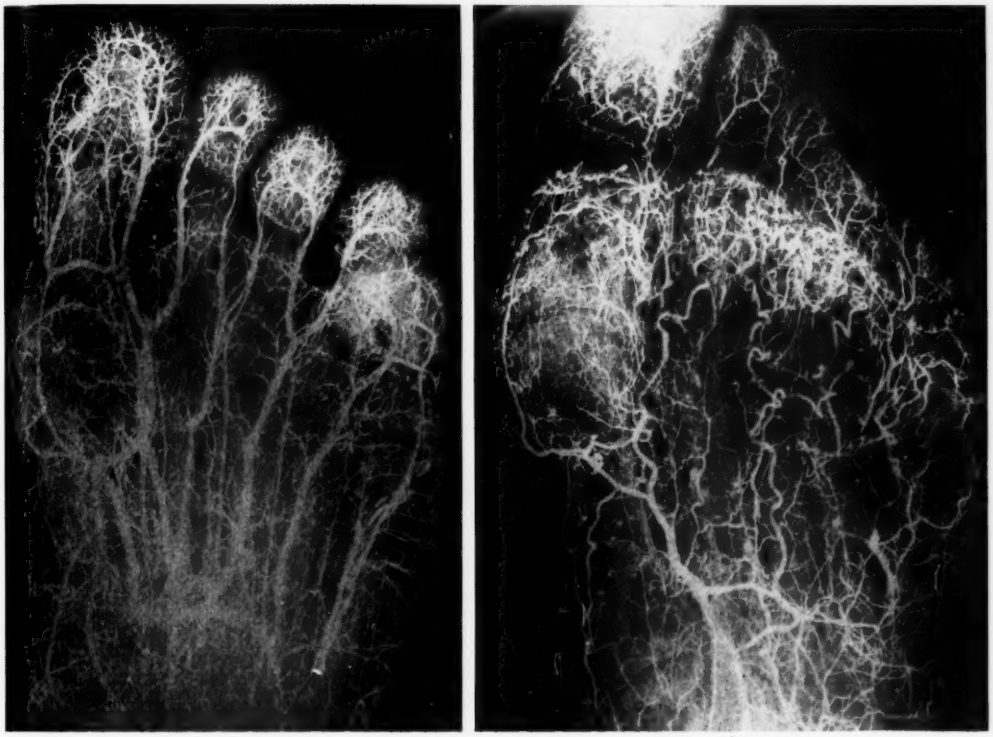
Collateral versus distribution systems. The name collateral is sometimes erroneously applied to any branch of an artery distal to an obstruction. Greater clarity should be achieved by using the expression "distribution system" for the branching beyond the anastomosis. In arteriosclerotic occlusion of the aortic bifurcation, e.g., the bypasses are completed proximal to the femoral artery. The femoral and its branches distribute the blood brought to the iliac arteries by the effluents of the anastomosis. The circulatory status of the distal tissues depends not only on the excellence of the anastomotic system, but also on the state of these distributing vessels. Among actual examples of chronic occlusion of large arteries, Edwards and Le May (16) found the incidence of gangrene directly proportionate to the state of the distribution system (Fig. 2).

Each obstruction in the distribution system may itself be bypassed by a little collateral system. However, as obstructions lie more and more distally, they come closer to involving the ultimate portions of the distribution systems for which there will exist fewer collaterals. Finally, when obstruction lies within the capillaries, death of a part, albeit a small one, is certain.

This principle explains uncommon loss of a limb after arteriosclerotic occlusion of the aorta (which tends to be a localized process) and the more frequent gangrene incident to obstruction of the tibial vessels (where the process is usually widespread). It is also exemplified in the frequent necrosis of a fingertip in a diffuse small artery disease, such as scleroderma, contrasted with the rare necrosis after occlusion of the brachial artery.

VULNERABILITY RELATED TO PATTERN OF BLOOD SUPPLY

The vulnerability of an organ or part to vascular occlusion depends considerably on the number of sources of its supply, as well as on the presence or absence of connections with neighboring vessels, or between the branches within the part. The only precise example of end arteries with absolutely no neighboring connections was described in the brain of the opossum by Wislocki and Camp-



a b

FIG. 2. Normal and abnormal distribution systems. a, Normal pattern, with strong plantar arch, plantar metatarsal, and digital arteries plus slender dorsal metatarsal and digital arteries. b, From a diabetic subject with occlusion of the popliteal artery, shows involvement of the pedal distribution system, with obstruction of the plantar arch, plantar and dorsal metatarsal, and proximal parts of the digital arteries.

bell but has not been observed in the human. Many parts of the human body are nevertheless quite circumscribed in their vascular supply, and obstruction may of course devitalize them. We are well accustomed to such conditions in the viscera. It is insufficiently appreciated that similar conditions prevail in peripheral muscles, nerves, and even areas of skin (14).

Variability in sources of supply. It is particularly important not to consider every multiple source arrangement as necessarily a safe one. In addition to considerations of physiology and pathology to be mentioned later, certain morphologic imperfections may be noted. The multiplicity of sources of supply are often exaggerated in description. It is often loosely said, for example, that the spinal cord is generously supplied by segmentally arranged branches of the parietal arteries. More precisely, as Suh and Alexander have emphasized, the supply is by 11 to 16 arteries, quite imperfect in segmental or symmetrical arrangement and imperfect in their anastomoses with each other. The veins are similarly disposed. The ureter, too, while receiving many small vessels, is to a great extent dependent upon a main artery derived from the lower aorta, or iliac arteries.

Variations frequently limit the number of vessels to a part, either because one or more vessels are absent, or because a usual anastomosis is not present. The biceps

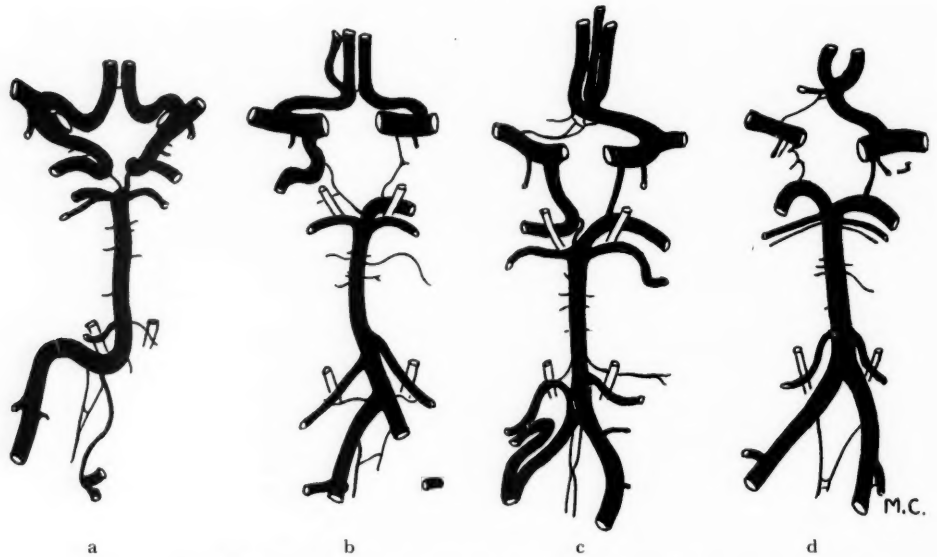


FIG. 3. Examples of discontinuity of the cerebral arterial circle, and of preponderance of various major arteries entering the anastomosis (after Hasebe, 1928).

brachii, for example, usually receives 2 to 8 arteries. Occasionally, there is but 1 artery of supply. In such an instance, division of this vessel may result in necrosis of the entire muscle, the small anastomoses at the ends of a muscle often being inadequate to quickly overcome the ischemia.

Aberrant breaks in normal anastomoses are not rare. In a large collected series, Hasebe noted that the carotid and basilar portions of the circle of Willis were separated on one side or both in 4.5 per cent (Fig. 3). Ehrmann found a break at some part of the circle, either absolute or as a filiform diminution, in 24 per cent (quoted in Hovelacque). Similarly, Barlow noted a "weakness" in the arcades connecting the jejunal arteries in 15.7 per cent, with a break in continuity at some point in 5.7 per cent.

Problems of junctional zones. Special vulnerability to ischemia exists in an area of junction of branches derived from 2 or more sources. The small vessels in such an area comprise the ultimate portions of a distribution system, i.e., they are acral branches. The interventricular septum and adjacent parts of the cardiac ventricles constitute an impressive example. This is the most frequent portion of the heart to show ischemic damage, anterior infarction being somewhat more frequent than posterior.

In the spinal cord, special vulnerability is said to exist in the thoracic segments, an area of junction between the anterior spinal artery from above, and the arteria radicularis magna and the smaller thoracic spinal branches from below.

The esophagus near the arch of the aorta and the pulmonary roots is noted as an area of poor healing after surgery. It is a zone of junction between branches of the inferior thyroid, bronchial, and left gastric arteries. Swigart and his co-authors compared the blood supply and hazard of ischemia here to that of the midportion of the rectum.

The vulnerability of the junctional zone is increased by variations in size and extent of the anastomosing arteries, in which one vessel through normal elongation and widening exerts a preponderant role in supply of the area. Schlesinger emphasized this for the coronary circuit (Fig. 4). He called the cir-

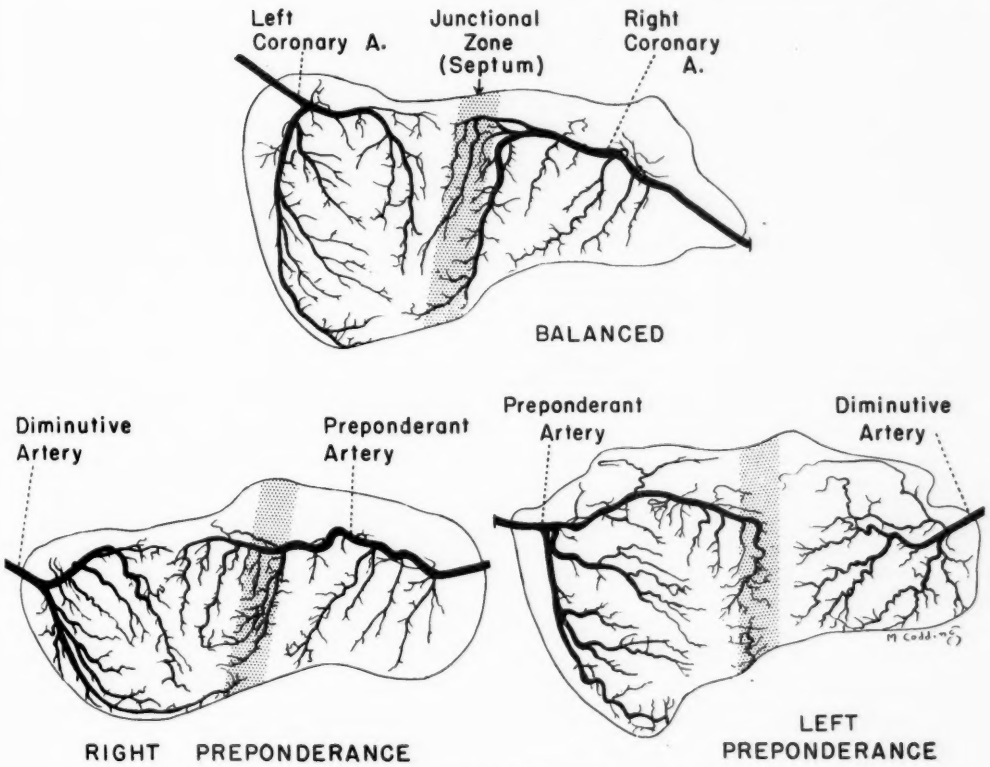


FIG. 4. "Balanced and unbalanced" circulation in the ventricles of the heart (after Schlesinger, 1940).

culation "balanced" when the two coronary arteries shared equally in the supply of the interventricular septum and neighboring parts of the ventricles. An "unbalanced circulation" was said to exist when one coronary supplied but little of this region, with the "preponderant" artery extending to much more than its usual territory. Occlusion of a preponderant artery was associated with great severity of myocardial infarction, and a high mortality.

The same principle holds for the multiple supply of the brain, where there is a high incidence of variation in size and origin of branches from each of the 4 parent arteries. It has often been pointed out that exceptionally extensive brain damage follows occlusion of a carotid or vertebral artery when it affords origin to more than its usual quota of branches. Suh and Alexander pointed out that the inequality in size of arteries and veins of the spinal cord, especially the presence of the arteria and vena radicularis magna, explains the occurrence of extreme myelomalacias after section or thrombosis of a single vessel. I have observed that the frequent collection of the major outflow of the intracranial venous sinuses into one internal jugular vein renders occlusion of that vessel, by pressure or thrombosis, capable of an unusual rise in cerebrospinal fluid pressure (9). This is undoubtedly also a factor in exceptionally deleterious effects after removal of one internal jugular vein in radical neck dissection for cancer.

Differences in external and internal arrangement. The degree of vascular circumscription of organs may differ considerably, not only

as regards the number of source arteries and communications between multiple vessels, but also as to the degree of communication between branches within the organ. The wide range of difference between external and internal vascular arrangement may be classified thus:

Gross anastomosis externally and internally: stomach, nerve, ureter.
Gross anastomosis externally; arteriolar anastomosis internally: brain, spinal cord, bowel.
Arteriolar anastomosis externally and internally: heart.
No anastomosis externally; large anastomosis internally: muscle.
No anastomosis externally; arteriolar anastomosis internally: hepatic and pulmonary lobe arteries.

The locations of externally located anastomoses are of significance to the surgeon. Thus intestinal branches may be ligated with impunity proximal to anastomotic loops in the mesentery, whereas ligation of the vasa recta gives rise to necrosis. Likewise stripping of the areolar tissue about the ureter removes the largest anastomoses of this structure and is thought to predispose to necrosis as pointed out by Michaels. Similarly, Sunderland points out that in mobilizing a nerve the surgeon should divide a nutrient vessel at a distance from the nerve to avoid injury to the longitudinal network of vessels lying directly on its external surface.

SUPPLEMENTARY CIRCULATIONS

Adjustment to vascular obstruction in the liver, lung, and heart involves connections between systemic vessels and vascular circuits of specialized nature. The term "supplementary," rather than collateral, is proposed for such a compensatory circulation. In all these instances channels between two systems of diverse nature are demonstrable, yet physiologically the anastomoses entail certain imperfections based on differences in blood pressure, content of blood, or direction of flow.

The liver. Obstruction of the hepatic artery normally exerts but little effect on hepatic vein flow, yet the liver suffers severely. Alessandri found that ligation of the main hepatic artery in 10 human cases was followed by 6 fatalities, while ligation of 1 major branch in 8 cases gave rise to 7 deaths. Communications exist between the portal sinusoids and hepatic branches; yet it is unlikely that the perfusion of the hepatic capillaries could be adequate because normal portal pressure is only about one-fifth that in the systemic arteries, and the blood is venous in character. Apparently it is the lack of adequate oxygenation which is significant after the arterial ligation; since, as Markowitz, Rappaport, and Scott have shown in the dog, death is due to anaerobic infection. Antibiotics for a few days allow survival, apparently adequate arterial communications developing from extrahepatic sources.

Obstruction to the portal flow, as in portal cirrhosis, involves the problem of adequate perfusion for liver function as well as that of portal hypertension. Pressure in the portal system rises from the normal range of 100 to 300, to levels of 250 to 600 millimeters of water, while at the same time flow through the portal vein is reduced. There is considerable evidence that there is a concomitant increase in hepatic artery flow to compensate for the lack of perfusion of the liver. Taylor and Rosenbaum found that, while reducing hepatic artery pressure had but little effect on hepatic vein flow in a normal liver, this maneuver significantly reduced the already lowered hepatic vein flow of the cirrhotic liver. The hepatic arterial supplement to portal sinusoidal perfusion is possibly beneficial; yet it fails to restore the normal channeling of digestive outflow to the liver, and it contributes to the dangerous elevation of portal pressure.

With portal outflow obstructed, some bypass for portal blood is necessary if the circulation of the portal watershed is to continue. The outlet is, of course, comprised of the porta-systemic communications, which I have shown in a previous article to be normally open and available (12). Here again the supplementary circulation has two disadvantages, the first of which is that the anastomotic vessels in the stomach and

esophagus often undergo varicose enlargement and rupture. The second disadvantage is that, the more adequate the communications, the less blood presented for action by the liver. This reaches its acme in the presence of large natural or surgically produced shunts, when liver coma is rather easily produced by meat eating and consequent high blood ammonia level.

The lung. The connections between the two vascular systems of the lung are utilized in obstruction of either, with various degrees of success. The effects of bronchial artery obstruction in man are not known. In the dog, Ellis, Grindlay, and Edwards (18) produced extensive ulceration of the stem and lobar bronchi after an injection of an occluding mass into the bronchial artery. They concluded that the pulmonary artery is, however, capable of nourishing the pulmonary and bronchial tissue distal to the hilar region.

The bronchial artery can compensate for extensive pulmonary artery obstruction, especially when other systemic arteries assist. In the dog, Cockett and Vass found that ligation of a major pulmonary artery was followed by huge enlargement of the anastomosing bronchial system. If the pleura were now stripped away, additional anastomoses developed from intercostal arteries. This supplementary circulation was able to sustain the life of the dog when the opposite bronchus was obstructed. Liebow and his associates have added brilliantly to our knowledge of the role the bronchial arteries play in supplementing pulmonary artery flow in a variety of states. They have demonstrated grossly visible anastomoses between the two systems in congenital pulmonary atresia, pulmonary embolism, and inflammatory disease such as bronchiectasis and tuberculosis. Apparently, the bronchial blood flow makes up by its large volume for the failure of presentation to the lung of blood of low oxygen content. One incidental benefit in localized disease such as bronchiectasis is that the entrance of blood under the high systemic pressure creates a block within the pulmonary artery tree to the flow of pulmonary arterial blood to the diseased part. Thus the pulmonary blood is diverted to neighboring normal lung where it can best be acted upon.

The greatest defect of this anastomotic connection is that it represents a shunt of considerable magnitude, from left ventricle to pulmonary veins, so that the output of this chamber may be increased by as much as one-third. The increased burden may lead to hypertrophy and failure of the left side of the heart. In some instances the bronchopulmonary anastomoses give rise to enough back pressure in the pulmonary arteries as to increase the work of the right side of the heart as well. Liebow and his associates further believe that the massive hemoptysis of bright red blood in bronchiectasis is due to the rupture of anastomotic channels greatly distended by the high systemic pressure. Ellis, Grindlay, and Edwards (19) concluded from experimental pulmonary embolism that the hemorrhage into an infarct is likewise attributable to the high pressure of bronchial artery blood.

The bronchial veins offer a supplementary path for return of pulmonary blood in mitral stenosis, where the pressure in the left atrium and pulmonary veins is high. Here again connecting vessels in the bronchial mucosa may give way under the unaccustomed pressure, with resultant hemoptysis.

The heart. Connections between the two coronary arteries or between coronary and pericardial arteries and veins constitute collaterals of ordinary variety. Blood flows that we must regard as supplementary are those from the coronary sinus to the capillaries and from the ventricular cavities via the sinusoids to the coronary system—the so-called thebesian system. The demonstration of the morphology of the latter channels by Wearn and his associates satisfactorily affirms their existence. By artificial retrograde perfusion of the sinus with oxygenated blood, Gott and his associates have maintained good nutrition of the heart during "open heart" surgery in humans.

Survival after total occlusion of both coronary arteries has been noted in several reports cited by Wiggers. The assumption is generally made that survival depends upon the thebesian and extracoronary communications. The functional value of the thebesian system is, however, open to doubt. Nourishment by coronary venous backflow appears unlikely in view of its low oxygen content and low pressure. As regards the ventriculoarterial connections, Wiggers points out that pressure differentials preclude exchange under normal conditions. With partial coronary occlusion, flow from the left ventricle to coronary branches could occur during systole; but the flow may reverse from artery to ventricle during diastole. With complete occlusion, ventricle to artery flow may indeed be present throughout the cardiac cycle. Even less certain is flow from the right ventricle because of the low pressure engendered here. Right ventricular blood again is poorly oxygenated. The matter is further uncertain as regards both ventricles because of the probable constriction of the capillaries during much of systole.

An anomalous origin of the left coronary from the pulmonary artery, of which over 40 cases have been reported, involves another type of supplementary circulation. According to Bassis and Sheinkopf, such a blood supply to the left ventricle, with low pressure and oxygen content, leads to necrosis and fibrosis of the muscle, reactive occlusions of the coronary branches, and early death. A similar anomaly of the right coronary artery is apparently less serious.

FACTORS GOVERNING ADEQUACY OF COLLATERAL SYSTEMS

Morphologic. The best collaterals are those which are wide and short since, as mentioned, the flow across multiple small channels can hardly equal that across a single large one; while long vessels increase total friction. This means that precapillary anastomoses are not as effective as arterial and that a reticulate anastomosis is inferior to an inosculation.

The pattern of involvement by disease is very important since vessels theoretically available may be occluded. Thus, in both veins and arteries, simple ligation is associated with a better collateral flow than thrombosis since the latter process may occlude significant branches or tributaries. The scanty collaterals of the popliteal region are often crucially reduced in war wounds of this area, partly by the wide local damage of such wounds and partly by the débridement that is necessitated. Arteriosclerotic occlusion of the aorta and iliac arteries furnishes another example. Edwards and LeMay (16) found that in this disease there is concomitant occlusion of the inferior mesenteric in 37 per cent, and of one or both hypogastric arteries in 29 per cent. The possibility of multiple sites of occlusion and further damage to the acral vascular distribution has been mentioned earlier.

Variations in collateral adequacy of the intracranial venous system have been related to the exact location of lesions. It has been known for some time that ligation of the superior sagittal sinus in its posterior portion is usually followed by hemiplegia, but obstruction of the anterior third is not. Merwarth points out that this is probably related to the site of termination in the sinus of the rolandic or postcentral vein, since impedance to outflow from this vessel perhaps invariably produces hemiplegia. Symonds relates hydrocephalus to thrombosis of the posterior part of the superior sagittal or lateral sinuses because of obstruction to the outflow of cerebrospinal fluid. The results of obstruction by tumor of various parts of the intracranial venous outflow are analyzed by Gibbs.

Local functional factors. Spasm affecting collateral or distribution arteries may impair the usefulness of otherwise adequate collateral systems. This is clearly demonstrated in the upper extremity, where the lodgement of an embolus or the contusion of an artery may give rise to a widespread arteriospasm of the limb severe enough to lead to gangrene. Similarly, spasm of the anterior tibial

artery appears to account for some cases of necrosis of the contents of the anterior tibial compartment.

Position of the part is significant by virtue of adding or removing hydrostatic pressure to a diminished pressure in collaterals. An arteriosclerotic limb, for example, is often aided by elevating the head of the patient's bed, while gangrene may be precipitated by elevation of the limb. This significance of position is further emphasized in the report of Nicholson, Foster, and Heath of the production of gangrene in a child's limb with normal circulation, when fracture of the femur is treated by traction with the limb drawn vertically upward (Bryant's traction).

Gradual enlargement of the collaterals occurs with the passage of time. It is commonplace to find, after arterial reconstruction, that even the major pulses require some days to acquire maximal or near maximal amplitude. The oscillometric readings in cases personally followed after lumbar sympathectomy often required 12 or 18 months to reach their highest levels. That the time required for collateral enlargement should actually be measured in years is documented by Ray and Burch, who found that the venous pressure distal to caval ligation falls over a period of 4 or more years; and by Wright and his associates, who observed an improvement in the femoral arterial pressure and pulse contours, extending over the 7 years following correction of aortic coarctation.

The functional need for blood varies widely for different tissues and is of utmost importance in determining survival during the time required for collaterals to develop and the adequacy of circulation at the time of maximal collateral flow. As extremes, one may contrast skin, which can be cut for a graft and be viable after a week's storage in a refrigerator, with nerve tissue, which may die in a matter of seconds on being deprived of its circulation. The ultimate result of ischemia depends somewhat on the location of the cell nucleus. Thus, in a limb rendered ischemic beyond 4 or 5 hours, the skeletal muscle may be totally necrotic while the peripheral nerves, whose nuclei lie in the spinal cord and posterior root ganglia, may be intact or only slightly damaged.

The state of activity of the tissue may cause inadequacy of a collateral circulation. Thus a patient with occlusion of a limb artery may be comfortable at rest but develop intermittent claudication on activity. Similarly, the compensation for coronary occlusion may be adequate at rest while angina pectoris or myocardial infarction may be produced with exercise. With respect to the veins, it has been noted that ligation of the inferior vena cava may be compensated for by collaterals with normal peripheral venous pressure at rest but with a rise to abnormal levels after exercise. The state of activity and consequent need for blood may be increased by heating and diminished by cooling of the part. Freeman documented the effect of heating and affirmed the clinical observation that heating an arteriosclerotic limb may precipitate gangrene. That cooling may render adequate an otherwise poor collateral system was early noted by Allen and is the cornerstone of current surgery under hypothermia.

Injury of a part creates an extreme need for blood and may overturn the balance of blood supply and blood requirement. The factor of infection has been shown to be responsible for an exaggeration of poverty of collaterals in the intestinal and hepatic territories. Thus Sarnoff and Poth showed that the necrosis which follows venous occlusion of the intestine can be prevented by giving an antibiotic during the early period of collateral enlargement. Cohn and Rives established the same sequence after an arterial obstruction; and Markowitz, Rappaport, and Scott showed that the liver could be similarly protected after ligation of the hepatic artery.

General functional factors. The conditions in the body at large which may alter the adequacy of a collateral system are those affecting metabolic activity and those affecting blood flow or blood content. As an example

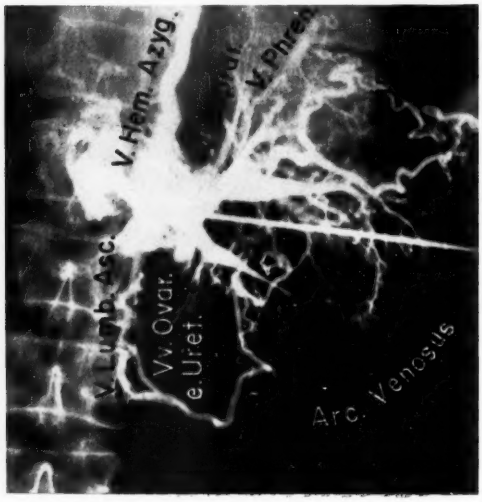


FIG. 5. Collaterals of an obstructed left renal vein demonstrated during life. The preservation of the kidney may be assured by such collaterals, but this may be harmful to the organism as a whole because of the development of nephrosis.

of the first, may be cited the relief from angina pectoris which often follows depression of thyroid function through the administration of radioactive iodine.

Diminished blood volume or lowered blood pressure decreases the volume of blood flow and thus is conducive to inadequacy of collateral systems. When peripheral vasoconstriction is present, as in shock and hemorrhage, the flow across a collateral system of a limb is further impaired. The higher figure for gangrene after war wounds of arteries as contrasted with those for deliberate ligation of the same arteries in civilian practice is undoubtedly due in the main to these factors. Similarly, it is well known that simple lowering of the blood pressure may produce myocardial infarction in the presence of established coronary occlusion. Meyer, Leiderman, and Denny-Brown have also demonstrated that lowering the systemic blood pressure in patients with arteriosclerosis of the carotid or basilar arteries can induce severe electroencephalographic changes and symptoms of cerebral ischemia. The same authors have previously shown that a high systolic pressure is crucial in the evolution of collaterals from cortical vessels when obstruction is produced in these smaller arteries.

The quality of the blood perfused is likewise important. It is known, e.g., that angina pectoris may be alleviated when anemia is corrected and the oxygen carrying capacity of the blood is thus improved. On the other hand, the abnormally high erythrocyte content of polycythemia is associated with an increased blood viscosity. Ischemic symptoms in this disease may be improved after reduction in the number of red cells.

PECULIARITIES OF VENOUS COLLATERALS

In general, the multiplicity of veins and their freer anastomoses as contrasted with arteries allow for less interference with flow after venous occlusion than after that of arteries. Nevertheless, collateral inadequacy may be observed, based on details of morphology as well as on the nature of various diseases.

One morphologic difficulty is the exceptional importance of a single vein in some regions. Examples are the central vein of the retina, the portal, the mesenterics, and the renal. The closure of such veins causes gross interference with outflow and frequently results in necrosis. Other veins are moderately preponderant; examples are the venae cavae, the axillary, the popliteal, and veins of the spinal cord, and of the brain. Occlusion of such vessels gives rise to necrosis if the part is sensitive and collaterals are missing, as often is the case in the spinal cord, or to gross dysfunction as in the kidney (Fig. 5). Where conditions are not quite so critical, as in the limbs, moderate dysfunction may result.

The orientation of valves sometimes prevents an anastomosing channel from functioning as a collateral. A true collateral extends from one segment of a parent trunk—that is, a portion between two valves—to another segment. The collateral may be valved, but the valves must all be directed centripetally to allow a bypassing of the ob-

structed trunk. A second type of channel, which was named a "venous circle" by Braune, contains valves oriented toward each of its extremities so as to cause a bifurcated flow from a "divide" somewhere along the course of the channel toward each end of the circle. Braune indicated that this situation exists in some of the connections of the femoral and pelvic veins; this was confirmed by Edwards and Robuck (17). The veins of the anterior abdominal wall are similarly disposed, the divide being located about the level of the umbilicus. The valve arrangement thus prevents the flow of blood from these tributaries of one vena cava to those of the other cava. Indeed, injection experiments and clinical experience have shown that these vessels invariably fail to act as collaterals soon after deep venous obstruction (12, 15), but can do so after the valves become incompetent—a change which requires a dilatation of the vein beyond twice its original diameter (10).

It has been mentioned that thrombosis causes more occlusion and is therefore less easily compensated for by collaterals than does simple interruption, in either arteries or veins. Thrombosis as may occur in patients with carcinoma may be sufficiently widespread as to occlude even the multiple channels of a limb and give rise to gangrene. When arterial pressure is lowered, as in an arteriosclerotic limb, even a fairly limited venous thrombosis may be inadequately compensated for by collaterals and may precipitate gangrene as shown in a previous article (13).

Inadequacy of venous collateral present during exercise is traceable partly to inadequate channel to accommodate the increased demand and partly to the valve destruction consequent upon the thrombotic process. The pathologic process involved has been described in a former communication (15).

CONCLUSIONS

Angiographic and other data help clarify the definition of collaterals, the degree of vascular isolation of various structures, the collaterals in actual use, and their effectiveness.

Collaterals should be differentiated from the ultimate vessels which lie distal to the occlusion and which may be open or occluded. A second vascular system, as in the lung, heart, or liver, constitutes a "supplementary" variety of collateral. It may be ineffective because of differences in pressure or content. Bypassing an organ may be harmful, as when systemic diversion prevents the liver from acting on portal blood.

The degree of vascular isolation of an organ may differ from that of its constituent parts.

One channel of an anastomotic system may be long or wide at the expense of the other vessels. With such "unbalance," occlusion of a "preponderant" artery occasions more ischemia than occlusion of the diminutive vessel.

The effectiveness of collateral systems depends on: (1) the size of the anastomoses; (2) the occlusion pattern as regards collateral involvement; (3) functional needs of the tissue; (4) general factors affecting blood flow and blood content.

In at least one paired organ, the kidney, total necrosis of a single member is less harmful to the patient than survival of the organ with a reduced arterial or venous circulation.

Portions of the body vary in degree of vascular isolation as much with respect to the veins as to the arteries. In some locations, valves oppose collateral flow until dilatation engenders incompetence.

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A PHENOMENON OF INDUCED LOCAL REACTIVITY IN EXPERIMENTAL TUMORS

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WHEN A SUSPENSION of sarcoma 37 cells obtained from the peritoneal cavity of Swiss white mice is injected subcutaneously into a heterologous host such as a rabbit, absorption of the injected tumor mass begins within a few hours and is usually complete within 48 hours. The heterologous host appears to suffer no ill effects and growth of the injected tumor does not occur. This fact demonstrates the phenomenon of heterologous transplantation immunity. Despite the fact that little is known about this phenomenon, the mechanism can be modified by physical and chemical agents so that growth of a tumor transplant takes place in a heterologous host. Thus, it has been possible to transplant human tumors to rats previously treated by total body radiation and cortisone.

It is likely that by this treatment, the host defense factors are either weakened or completely destroyed, thus permitting the unimpeded growth and multiplication of the neoplasm within the heterologous host. The immunologic aspect of this phenomena is strengthened by the fact that homologous transplantation is possible in the absence of gamma globulin. Heterologous transplantation can be effected by cortisone alone. It is likewise possible that the host defense factors concerned in the restraint of tumor growth within a natural host may be similar or even the same as the factors responsible for heterologous transplantation immunity.

Previous investigators have demonstrated specific proteolytic agents in the blood and urine of tumor hosts which are effective against tumor substrates. The present study was carried out to investigate the possibility of causing the production of a specific proteolytic agent in the urine of a heterologous host during the period of active destruction of an injected heterologous tumor mass and then to test the effectiveness of the agent secreted in the urine against the growth of the tumor in its natural host.

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METHOD

Preparation of urinary extract. The mouse sarcoma 37 was maintained in the laboratory for transplantation by continued passage through the peritoneal cavity of Swiss white mice. The peritoneal fluid of 4 mice with the ascites form of sarcoma 37 was pooled and diluted with an equal volume of saline. Approximately 20 cubic centimeters of this suspension was then injected subcutaneously into each rabbit. The rabbits were placed in a metabolic cage, given an adequate supply of water, and maintained on the usual diet consisting of pellets. The urine was collected daily for the following 3 days. The urinary samples for each 24 hour period were processed separately.

Each sample was concentrated under reduced pressure to approximately one-tenth of the original volume. Absolute alcohol was slowly added to the resulting concentrated urine. The total amount of alcohol used was equal to half of the volume of evaporated urine. The fine precipitate was removed by filtration and the resulting clear solution further evaporated to one-tenth the volume. An equal volume of absolute alcohol was added to the final solution. The dense precipitate was recovered by vacuum filtration, was air-dried, and stored in a container at 4 degrees C. Similar extractions were carried

TABLE I.—RESULTS AT END OF 30 DAY EXPERIMENTAL PERIOD

	No. of animals	*No. in complete remission*	*No. in partial remission*	*No. with growing tumors*	*No. dead*
Controls.....	36	6	0	12	18
Treated with inactive urinary extract.....	30	2	0	5	23
Treated with active urinary extract.....	74	54	14	2	4

out on urine from rabbits which had not previously been injected with tumor cell suspension.

Tumors that had been removed for histologic investigation were fixed in Bouin's fluid. Sections were stained with hematoxylin and eosin.

Preparation of experimental animals. A tumor cell suspension similar to that described was used for the production of subcutaneous tumors. Approximately 0.25 cubic centimeter of the cell suspension was injected subcutaneously in the loin of the mouse. Animals were maintained on a diet of pellets. Within 5 days the tumor mass was approximately 1 centimeter in diameter. On this day test animals were given the first intraperitoneal injection of a solution of urinary extract. The concentration of the test solution was 10 milligrams per cubic centimeter. In all instances, injections were made into the free peritoneal cavity and at as great a distance from the tumor as possible. Animals showing complete necrosis within 24 hours did not receive additional injections. Others received a maximum of 4 injections. All animals were observed daily for necrosis and healing. Animals in remission were kept for at least 30 days in order to detect recurrences of tumor growth.

Six experiments involving a total of 140 animals were used in this study. Of this group, 36 animals were used as controls, 74 received graded injections of urinary extracts from rabbits that had been previously injected with a cell suspension of sarcoma 37, and 30 animals received injections of extractions from the urine of rabbits not injected with tumor cell suspension.

OBSERVATIONS

The first changes noted in the tumors of mice receiving the active principle from the urine of rabbits previously treated with sarcoma 37 cells involved the size and color of the tumor. During the following few hours the color of the mass deepened and in many instances assumed a final appearance of a hematoma. A hematoma developed in 17 animals within 3 hours. The earliest manifestation of effect was noted as early as 15 minutes after the initial intraperitoneal injection. The remainder of the 74 mice showing any response, usually did so within 24 hours. This was usually followed by coagulation of the hematoma. In 6 instances the entire hemorrhagic mass separated from the animal during the first 24 hours. In other instances, separation of the necrotic mass required a few days. The resulting ulceration did not become infected and healed within 2 weeks. Some of the animals exhibited a general reaction during the first 24 hours, consisting of anorexia and a poor appearance. Often this general response did not occur.

Of 74 mice treated with the active principle, 54 showed necrosis of the tumor mass followed by sloughing and eventual healing of the denuded area as the result of the injection. In these animals there was no evidence of recurrence during the experimental period. In an additional 14 mice, sloughing of the tumor was observed after the injection of urine extract, but this was followed by local recurrence of the tumor at the periphery of the ulcerated area. The tumor growth in these instances was not sufficient to cause the death of the animal during the experimental period. The most rapid responses were noted with material obtained from urine 48 hours after the rabbit had received an injection of tumor suspension. Tests with material extracted from rabbit urine 24 and 72 hours after the injection of tumor suspension proved somewhat less effective than the 48 hour material. The optimal doses appeared to be 4 milligrams. Doses of 8 and 16 milligrams were less effective in producing effects within the tumor.

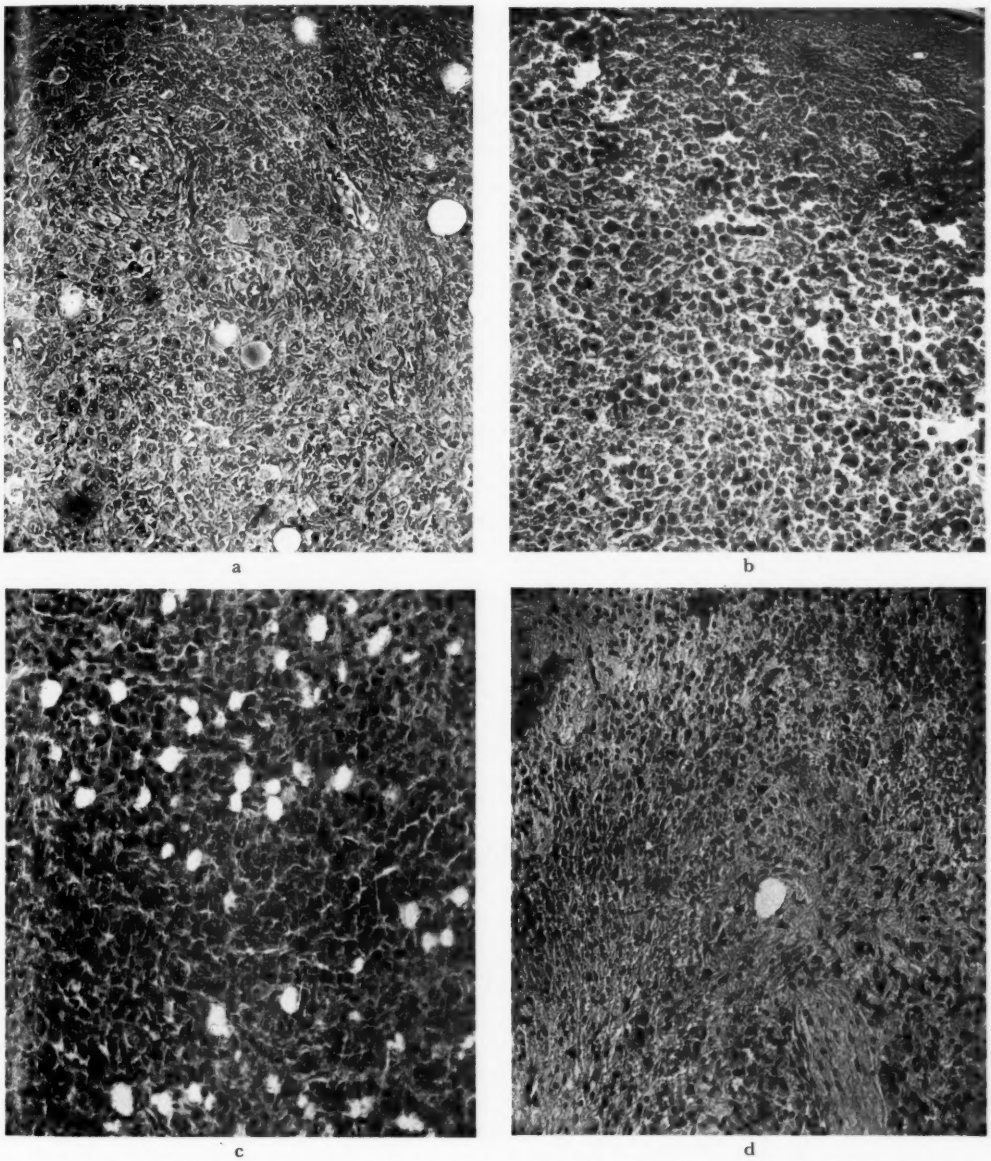

FIG. 1. Cellular effects of the active principle on mouse sarcoma 37. a, Microscopic appearance of control tumor (Experiment 4). b, Microscopic appearance of mouse tumor (Experiment 4) 24 hours following injection of 4 milligrams active principle obtained from 72 hour urine. c, Microscopic appearance of control mouse tumor (Experiment 6). d, Microscopic appearance of treated experimental tumor (Experiment 6) 72 hours following injection of 3 milligrams active principle obtained from 48 hour urine.

Death occurred within 24 hours after the injection in 4 mice. Death from tumor at this stage of development does not usually occur. An absence of effect on the tumor was noted in 2 animals. In these instances, the tumors grew at the same rate as in controls.

Of 30 animals receiving material extracted from the urine of rabbits not previously injected with tumor cell suspension, none developed the hyperemia followed by necrosis and slough noted in the previous group of animals. The tumors appeared to grow at approximately the same or slightly accelerated rate as did the controls. Death as a result of tumor growth occurred in 23 mice during the period of the experiment. Generally, these tumors were larger than control tumors, an average diameter of 30 millimeters. Complete remission was noted in 2 animals during treatment. In none of these mice were acute effects observed after the intraperitoneal injection. The first evidences of remission occurred 9 days after the last injection.

The control tumors usually continued to enlarge until the animal died. The average diameter of tumors at this stage was 25 millimeters. Some tumors attained a diameter of 35 millimeters. Spontaneous remissions occurred in 6 untreated tumor mice. In these, the remission usually began after the tumor was approximately 15 millimeters in diameter. The phenomenon occurred by central necrosis followed by slough. In these instances the necrosis did not occur as rapidly nor abruptly as had been noted in experimental animals. Death occurred within 30 days in 18 animals as the result of tumor growth. The remaining animals succumbed as a result of tumor growth at varying times during the following 30 days.

Microscopically, effected tumors showed hemorrhage and cell necrosis (Fig. 1). There was only occasional evidence of intravascular thrombosis. The blood vessels were engorged with blood elements. Many of the tumor cells showed fragmentation of cytoplasmic and nuclear elements. Sections through sloughing areas showed necrosis extending to the base of the tumor with occasional islands of apparently viable tumor cells. As the process advanced, infiltration with inflammatory cells was noted. This was followed by fibroplasia and healing of the denuded area.

DISCUSSION

The gross and microscopic appearance of the local tissue reaction described in this article is comparable in some respects to that described by Schwartzman following the injection of preparatory doses of various bacterial toxin and the provocative administration of such nonbacterial substances as kaolin, starch, glycogen, and acidic polymers of high molecular weight. Local tissue effects were also produced following intravenous and intraperitoneal injections of bacterial filtrates of Bacillus coli, Proteus vulgaris, and meningococcus. There are, however, the following points of difference. The active principle present in the urinary extract of rabbits treated with tumor suspension fails to cause intravascular thrombosis. Necrosis appears to occur at a cellular level. The mortality of tumor animals treated with the active principle present in the urine of a heterologous host is less than that observed when tumor animals are treated with bacterial filtrates. In addition, the tumor regression rate in the experiments described is higher than that obtained with the bacterial products.

The active principle apparently does not exist as a normal component of rabbit urine, at least in effective amounts. The experiments using material obtained by a similar extraction of urine obtained from rabbits not previously injected with sarcoma cells failed to elicit the reaction. The active principle appears to be present in greatest concentration during the period of most active destruction of the heterologous transplant. Thus extraction of urine obtained at 24 hours and 72 hours following the subcutaneous injection of tumor into the heterologous host appears significantly less active than the 48 hour samples.

Abderhalden observed that human blood serum and urine were capable of digesting a protein substrate which had previously interacted with the host. He was able to demonstrate the digestion of a substrate consisting of placenta by serum obtained from a pregnant woman. The highly

specific substance was shown to be present in the urine in higher concentration than in the blood and was thought to be an enzyme. The active principle was isolated by acetone and alcohol precipitation. He postulated that this effect was due to the development of a defense enzyme, proteolytic in nature. The demonstration of the ability of the serum of a pregnant woman to digest a substrate consisting of human placenta suggests perhaps the control mechanism which prevents the development of disseminated malignancy originating in the chorionic cells of the placenta. Undoubtedly some mechanism is responsible for the continued destruction of chorionic cells which are known to be present in the circulating blood and in the organs of pregnant subjects.

The active principle described in this article and demonstrated in the urine of a heterologous host following transplantation of tumor tissue from the natural host might possibly be a proteolytic enzyme similar to or the same as the "Abwehrferment" described by Abderhalden. If this be true, then it might also be possible selectively to prepare the specific defense enzymes for a variety of tumors. The parenteral administration of the substance obtained from the urine of the heterologous host might then produce a phenomenon of local reactivity in the tumor of the homologous host. Such studies involving a variety of tumors are now in progress.

SUMMARY

1. An active substance capable of producing tumor necrosis in sarcoma 37 of Swiss white mice has been demonstrated in the urine of a rabbit receiving a heterologous tumor transplant from a mouse.

2. This substance could not be demonstrated in the urine of rabbits untreated with the heterologous tumor transplant.

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CANCER OF THE STOMACH AFTER GASTRIC RESECTION FOR PEPTIC ULCER

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SCATTERED REPORTS of gastric cancer developing after resection for peptic ulcer have appeared in the literature. However, in only 1 instance has a series of as many as 11 cases, that of Helsingen and Hillestad, been studied thoroughly. Because detailed review of the first surgical specimen has never been made at the time of these reports, it was decided to undertake a clinicopathologic study of 17 cases with emphasis on the pathologic characteristics of the stomachs resected at the time of the first operation.

MATERIAL AND METHOD

The cases of gastric cancer recorded in the surgical files of the Mayo Clinic for the period 1905 through 1954 were examined to determine those in which gastric resection for peptic ulcer had been performed before the development of cancer. During this 50 year period, there were 5 carcinomas of the gastric stump, referred to hereinafter as the group in which resection was performed for peptic ulcer. There were also 12 cases of gastric cancer following simple excision of an ulcer, usually with gastroenterostomy; these constitute the group in which resection was not performed for ulcer. Because of the aim of this study, only those patients who had both operations performed at the Mayo Clinic were included in the series. Data from the case records and from gross and microscopic study of the surgical specimens form the basis of this report.

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REPORT OF CASES

CASE 1. A 52 year old man was seen in December, 1934, with a history of peptic ulcer of 20 years' duration. X-ray examination with the aid of barium showed a gastric ulcer. A Polya type of gastric resection was done, and the patient was free of symptoms for almost 16 years. He returned in August, 1951, with a history of abdominal discomfort, vomiting, hematemesis, weakness, and tiredness.

A hard mass was palpated in the left upper quadrant. X-ray examination gave the picture of an extensive jejunal ulcer in the distal loop. At operation, a huge mass was discovered in the region of the stoma. Biopsy of lymph nodes in the mesojejunum showed metastatic adenocarcinoma.

CASE 2. A 34 year old man was seen in May, 1942, complaining of typical ulcer symptoms that he had had for 12 years. A duodenal ulcer was seen on x-ray examination. He underwent subtotal gastric resection and remained free of symptoms for 6½ years.

When he returned in January, 1949, he was suffering from dysphagia and loss of weight. X-ray examination showed an annular carcinoma of the terminal part of the esophagus. Total gastric resection and splenectomy were done. On pathologic examination the tumor was found to be an adenocarcinoma of the cardia with involvement of the esophagus and lymph nodes.

CASE 3. A 40 year old man was seen in January, 1940, giving a history of periodic attacks of epigastric pain. X-ray examination showed a gastric ulcer on the lesser curvature above the angle. Gastric resection was done and a benign ulcer was found. The patient remained free of symptoms for 12½ years.

He returned in December, 1953, with a complaint of periodic epigastric pain that he had had for 13 months. Lately, he had had nausea, vomiting, loss of weight, and weakness. A large ulcer of the efferent jejunal loop was reported on x-ray examination. At exploration, a huge ulcerating lesion was found surrounding the gastroenteric stoma. Biopsy of a lymph node in the mesocolon showed metastatic adenocarcinoma.

CASE 4. A 45 year old man was seen in November, 1940. At that time he gave a typical history of peptic ulcer of 2½ years' duration. The lesion on x-ray ex-

amination was reported as a duodenal ulcer. However, at operation the duodenum was found to be normal, but gastric resection was done for 2 benign gastric ulcers situated above the pylorus. The patient remained free of symptoms for 10½ years.

He returned in November, 1951, complaining of epigastric pain, tarry stools, nausea, vomiting, and loss of weight. Exploration revealed a tumor of the lesser curvature involving both walls of the resected stomach. Biopsy of the lesser curvature showed adenocarcinoma.

CASE 5. A 36 year old man was seen in 1926. He had suffered from a duodenal ulcer for 18 years and had undergone gastroenterostomy. X-ray examination showed a gastrojejunal and a small gastric ulcer on the lesser curvature above the angle. Gastric resection was done for these 2 lesions, and the patient remained symptomless for almost 24 years.

He returned in January, 1952, with a history of dull aching pain in the left lower quadrant, weakness, and vomiting of 2 years' duration. X-ray examination showed a malfunctioning gastrojejunal stoma with a questionable gastrojejunal ulcer. At exploration a hard mass was found in the region of the stoma. There were metastatic lesions in the liver. Needle biopsy of the liver disclosed metastatic adenocarcinoma.

CASE 6. A 27 year old man was seen in March, 1918, complaining that for 2 years he had had epigastric pain that was not related to meals. X-ray examination showed a gastric ulcer. This ulcer was excised and gastroenterostomy was done. The patient remained free of symptoms for about 25 years.

He returned in February, 1943, complaining that for 2 months he had had anorexia, weakness, and loss of weight. A large mass was felt in the epigastrium. The radiologist reported a carcinoma involving the pyloric half of the stomach. At exploration the huge mass was found to involve practically all the lower half of the stomach and to be fixed posteriorly. Biopsy of metastatic lesions in the greater omentum showed adenocarcinoma.

CASE 7. A 57 year old man was seen in November, 1925, relating a typical history of ulcer of 12 years' duration. X-ray examination showed a duodenal ulcer. Excision of an anterior duodenal ulcer and posterior gastroenterostomy were performed. The patient was free of symptoms for 9½ years.

He was seen again in May, 1936, for epigastric pain, nausea, vomiting, and loss of weight. He was thin and pale, and "yellow skin" was noticed. X-ray examination showed a carcinoma in the distal half of the stomach. Subtotal gastric resection was done and an adenocarcinoma found in the pyloric end of the stomach.

CASE 8. A 57 year old man was first seen in March, 1921. For 1 year he had had epigastric pain relieved by soda, with occasional vomiting. A perforating gastric ulcer was seen on x-ray examination. The ulcer was excised. Posterior gastroenterostomy was done.

The patient returned in November, 1929, with anorexia and aching in the upper part of the abdomen. X-ray examination showed a gastric ulcer and a free gastroenteric stoma. At exploration, besides the gastric ulcer a tumor of the pylorus was found. Subtotal gastric resection was done and histologic examination showed a benign gastric ulcer and an adenocarcinoma of the pylorus.

CASE 9. A 32 year old woman seen in March, 1938, gave a typical history of ulcer of 10 years' duration. The x-ray diagnosis was that of a duodenal ulcer. The ulcer was excised and gastroduodenostomy was done. She was free of symptoms for a little more than 2 years.

She returned in August, 1940, with an illness of 1 month's duration. She complained of constant epigastric pain, nausea, weakness, and loss of weight. X-ray examination showed a large polypoid lesion on the middle third of the posterior wall of the stomach. Biopsy of 1 of the multiple enlarged nodes revealed lymphosarcoma.

Case 10. A 55 year old woman was seen in November, 1914. For 18 months, she had had typical symptoms of ulcer. X-ray examination was not diagnostic. On exploration she was found to have a gastric ulcer, and it was excised. She remained free of symptoms for 3½ years.

She returned in August, 1918, complaining of intermittent epigastric pain, bleeding, belching, and vomiting that she had had for 6 weeks. On x-ray examination an ulcerating lesion of the pyloric end of the stomach was seen. Her stomach was resected and she was found to have an adenocarcinoma.

CASE 11. A 59 year old woman was seen in August, 1926. She had had two spells of indigestion, 2 years and 5 months previously, consisting of nausea and vomiting for several weeks. X-ray examination showed a gastric ulcer. This was excised and posterior gastroenterostomy was performed. She remained well for 9½ years.

She returned in April, 1936, complaining of abdominal tenderness, nausea, vomiting, loss of strength, and weight. X-ray examination showed a carcinoma of the distal end of the stomach. Subtotal gastric resection and resection of a part of the transverse colon for an adenocarcinoma of the lower third of the stomach involving the colon were done.

CASE 12. A 49 year old man was seen in March, 1930. For 15 years, he had had typical symptoms of ulcer. X-ray examination showed a large gastric ulcer. This was excised and posterior gastroenterostomy was done. Following operation, his symptoms were abated "only 50 per cent."

He returned in January, 1955, complaining of epigastric burning and vomiting. At exploration a mass was found to involve the distal half of the stomach. Biopsy of nodes in the mesojejunum showed metastatic adenocarcinoma.

CASE 13. A 26 year old man was seen in January,

TABLE I.—SYMPTOMS AND SIGNS OF PEPTIC ULCER IN 17 PATIENTS

Symptoms and signs	*No. of cases*
Pain	16
Typical of ulcer	12
Not typical of ulcer	4
Epigastric tenderness	6
Loss of weight	6
Hematemesis or melena	5
Nausea and vomiting	4
Dehydration	2
Jaundice	1

Average duration before operation for ulcer, 7.4 years

1921. He gave a history of having had epigastric distress, nausea, and occasional vomiting for 3 years. Gastroenterostomy performed elsewhere 12 months previously had given no relief. X-ray examination of the stomach showed a patent gastroenteric stoma. Exploration disclosed a benign gastric ulcer which was excised. Nodes along the lesser curvature were the site of inflammatory changes. He remained free of symptoms for 18 months.

On a return visit in October, 1924, the patient complained of severe pain, anorexia, vomiting, and a loss of 30 pounds. X-ray examination showed a gastric ulcer high on the lesser curvature. Subtotal gastric resection was done for adenocarcinoma.

CASE 14. A 38 year old woman was seen in September, 1923. For 5 years she had had typical symptoms of ulcer. X-ray examination revealed a duodenal ulcer. This was excised and pyloroplasty was performed. She remained well for 10 years, when recurrent symptoms of ulcer appeared but responded well to medical management.

She returned in December, 1948, complaining of epigastric pain and pain in the lower part of the abdomen. She had lost 20 pounds and was anemic. X-ray examination showed an ulcerating lesion. Gastric resection was done and a carcinoma in situ found on the edges of a gastric ulcer.

CASE 15. A 33 year old man was seen in November, 1920, complaining of ulcer symptoms that he had had for 10 years. X-ray examination revealed a small gastric ulcer. This was excised and gastroenterostomy was performed. The patient remained free of symptoms for 17 years.

He returned in February, 1938, because of weakness. A polypoid carcinoma was found above the stoma on x-ray examination. At operation 2 sessile polypoid lesions were excised from the lesser curvature and 1 pedunculated polyp was removed from the greater curvature. The largest one was an adenocarcinoma. The others were adenomatous polyps. The patient died 5 years later.

CASE 16. A 25 year old man was seen in December, 1922, complaining of episodic left epigastric pain that he had had for 3 years. X-ray examination showed a duodenal ulcer. This was excised and pyloroplasty was performed. The patient was not relieved of his symptoms.

He came back in February, 1941, stating that his pain had shifted to the lower part of the abdomen during the last year. At operation an ulcerating lesion was found on the posterior wall of the stomach. Subtotal gastric resection was done. Histologically the lesion was an ulcerating adenocarcinoma.

CASE 17. A 43 year old man was seen in January, 1920, complaining of periodic symptoms of ulcer that he had had for 8 years. X-ray examination revealed a gastric ulcer. This was excised and posterior gastroenterostomy was performed. The patient remained well for 4 years.

He came back in August, 1928, saying that he had been short of breath for 4 years. X-ray studies with the aid of barium revealed a polypoid tumor on the posterior wall above the gastroenteric stoma, which was free. Segmental gastric resection was done and histologically the tumor proved to be an hemangioendothelioma.

TABLE II.—LOCATION OF PEPTIC ULCER IN 17 PATIENTS

Location	*No. of cases*
Stomach	
Lesser curvature	7
Posterior wall	2
Anterior wall	2
Lesser curvature and posterior wall	2
Duodenum	
Anterior wall	4
Posterior wall	2
Gastroenteric stoma	1
Total	20*

*Three patients had 2 ulcers each

FINDINGS

The clinical features are summarized in Table I and are discussed briefly in the comment. Only the pertinent pathologic findings will be related here. Grossly, the ulcers were usually single, gastric in location (Table II), and looked like ordinary chronic ulcers in all the cases. Five stomachs resected for peptic ulcer were available for study. None of these presented the picture of giant hypertrophy of the gastric mucosa. One of the stomachs showed thinning and smoothness of the mucosa throughout its surface, and all the others showed at least one area of such change.

The microscopic picture of the ulcers was characteristic—severe gastritis or duodenitis was evident in the wall surrounding the lesion.

The proximal part of the resected stomach was studied in the 5 cases. In none was any precancerous lesion present; in 2 cases of severe gastritis the interval between evidence of gastritis and development of cancer was 17 and 25 years; in 1 case of moderate gastritis it was 12 years; and in 2 cases in which the mucosa was normal the interval was 6.5 and 9 years respectively.

The malignant lesions included 1 sarcoma, 1 hemangioendothelioma, and 15 adenocarcinomas. The adenocarcinomas were usually located at the line of anastomosis in the patients who had undergone resection and in the lower part of the stomach in the others (Table III). Direct extension to vital organs and nodal and hepatic metastasis explain why so many lesions were not operable.

TABLE III.—SITE OF GASTRIC ADENOCARCINOMA IN 15 PATIENTS

Site	*No. of cases*
Group with previous gastric resection for ulcer	
Stoma	3
Cardia	1
Lesser curvature and walls	1
Group without previous resection for ulcer	
Lower part of stomach (below gastroenteric stoma)	5
Lesser curvature	3
Stoma	1
Posterior wall	1

COMMENT

The case records did not reveal any clinical peculiarity except that 3 patients had achlorhydria following a test meal; none of these underwent resection. Comfort and coworkers have stated that achlorhydria precedes in many cases the development of gastric carcinoma. However, in 1 of the patients in the present series carcinoma did not develop until 25 years later.

The symptoms of cancer (Table IV) were those seen usually, but the diagnosis was more difficult because of the previous history and operation. In the patients who had undergone resection the correct radiologic diagnosis was made only once.

Cancer occurring in this sequence has a poor prognosis according to the literature, and this was borne out in our series. However, 2 patients who did not undergo resection, in addition to the 1 patient with hemangioendothelioma and the 1 with carcinoma in situ, have had a long term survival.

We have included in our series a patient who was found to have a reticulum cell sarcoma 28 months after excision of a gastroduodenal ulcer. At that time there was no evidence of a malignant lesion in the stomach. Microscopic examination of the ulcer in 3 other cases, in which the interval between operations was between 3 and 5 years, did not show any malignant change.

In only 1 of our malignant lesions was a multicentric origin obvious. A similar case was described by Singer and later by Ransom.

The adenocarcinomas seen in our series did not present any special pathologic feature as compared to an ordinary group of surgical specimens reported on by Dockerty, except that the grade of the lesion was lower, 6 grade 2 adenocarcinomas being found in a total of 15.

We have found only 1 carcinoma located at the cardia. However, Debray and coworkers, in their 7 cases, found a high incidence of carcinoma in this location. But, since they did not make a pathologic diagnosis in all of them, some of the lesions may have been squamous cell carcinomas originating in the lower part of the esophagus.

TABLE IV.—SYMPTOMS AND SIGNS OF MALIGNANT LESION OF THE STOMACH IN 17 PATIENTS

Symptoms and signs	*No. of cases*
Pain	13
Loss of weight	11
Nausea or vomiting or both	11
Weakness	7
Tenderness	6
Anorexia	4
Constipation	3
Dyspepsia	3
Pallor	3
Hematemesis or melena	2
Mass	2
Diarrhea	1
Dysphagia	1
Dyspnea	1

Average duration before operation for cancer, 7.5 years

It is noteworthy that our series includes the following: 1 reticulum cell sarcoma, 1 hemangioendothelioma, and 1 carcinoma in situ.

Most authors have stated that gastric cancer after resection for peptic ulcer is very rare. Recently, however, reports by Helsingen and Hillestad, Kühlmayer, Kühlmayer and Rokitansky, and Rømcke and Sponland, based principally on necropsy cases, tend to show that gastric adenocarcinoma is more frequent in patients with previous gastrectomy for gastric ulcer than in the general population. A previous duodenal ulcer does not have this relationship, or is thought to diminish the likelihood of this complication. In this regard, our series of cases has no statistical significance because we do not know how many patients operated on for ulcer have subsequently developed cancer. However, the very small number of cases encountered would tend to support the theory as to the rarity of the lesion.

Hebbel has made extensive studies of the lesions of gastritis. The microscopic picture seen in the stomachs of those in our series that were resected for ulcer conforms to the one he describes as being the most frequent: antral gastritis and normal fundic mucosa with duodenal ulcer, and antral and fundic gastritis with gastric ulcer.

SUMMARY

This is a report on 17 patients with gastric cancer, of whom 5 had undergone gastric resection for peptic ulcer and 12 had undergone excision of their ulcer prior to the development of malignant disease. Twelve of the patients had gastric ulcer and 5 had duodenal ulcer. The clinical findings were not unusual in respect to both the benign and the malignant lesions.

The diagnosis of cancer was difficult because of the previous history of ulcer. Radiologic examination failed to visualize the lesion in most of the cases following gastric resection.

The evidence of gastritis did not bear any relation to the development of cancer. The higher proportion of low grade carcinomas in this series compared to ordinary surgical material is evident.

The small number of cases found during a 50 year period at the Mayo Clinic leads us to believe that cancer of the stomach rarely develops in patients who have been treated for peptic ulcer either by gastric resection or excision of the ulcer.

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CLINICAL EXPERIENCES WITH THE SURGICAL TREATMENT OF ACQUIRED AORTIC VASCULAR DISEASE

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DURING THE PAST 4 YEARS, 53 patients with a variety of aortic vascular lesions have been treated at The George Washington University Hospital and affiliated surgical services. This series is reviewed in an attempt to correlate our earlier impressions concerning the restoration of the aorta with our more recent convictions. Furthermore, such a review is intended to furnish an up-to-date record of our experiences since the first case of resection and grafting of the aorta was performed in January 1954.

At the time this series began, the renewed interest in homologous vessel replacement of vascular lesions was gaining momentum. Since that time blood vessel replacement with various plastic materials has been widely employed.

Many excellent reports of the early or immediate complications in such an operative procedure were to be found in 1954. Now the late or delayed complications are emerging from the longer follow-up periods. Although still small in number, this series encompasses what can be expected in dealing with such a vascular problem during a 4 year period.

The cases are divided into the anatomic locations of aortic arch, descending thoracic aorta, and abdominal aorta. Each group is then studied as to type of lesion, etiology, and the method of treatment, the latter being further subdivided into emergency and elective procedures. Results in such a review must include complications which will be classified as immediate, delayed, or late. Delayed complications are those which occurred after the patient was fully reacted from anesthesia. Late complications are those which occurred after the patient left the hospital "improved."

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AORTIC ARCH (INCLUDING ASCENDING ARCH)

A total of 14 cases of aneurysms involved all or part of the aortic arch (Table I). Two of these included the ascending aorta as well as the proximal arch. Five were of the entire transverse arch as well as its tributaries. In 1 case an aneurysm involving the innominate artery had eroded into the tracheal wall causing localized obstruction. In 1 case the lesion was at the innominate artery and adjacent arch. Another encompassed the transverse and distal arch including the carotid and subclavian vessels. The left subclavian artery and distal arch represented still another. The remaining 3 aneurysms were located in the distal arch. Three of these 14 cases were true saccular lesions superimposed upon a generally thickened and dilated arch.

The etiologic agents in each of the 14 cases of arch aneurysms were syphilis in 6, atherosclerosis in 3, trauma in 3, and 1 in which the agent could not be determined. There were no mycotic aneurysms. The 3 saccular aneurysms were of luetic origin. As would be expected, all 3 traumatic lesions were located in the distal arch in proximity to the ligamentum arteriosum.

Treatment. Under methods of treatment are included type of graft used, and one or a combination of two of the following adjunct techniques (Table I). Four methods were considered in the support of circulation to protect body tissues against prolonged anoxia.

TABLE I.—AORTIC ARCH OPERATIONS

Case No. *Age* *Sex*	*Adjunct techniques*	*Operative dissection completed*	*Extent of grafting*	*Type of graft*	*Postoperative complications*	*Survival from date of graft*
1 25 M	Hypothermia	Yes	Aneurysmorrhaphy			45 mos. (A&W)
2 54 M	Hypothermia	Yes	Aneurysmorrhaphy			44 mos. (A&W)
3 22 M	Hypothermia	Yes	Distal segment	Homologous		30 mos. (A&W)
4 48 M	Hypothermia, staged segmental occlusion	Yes	Entire arch	Homologous	Embolism	18 hours
5 55 M	Hypothermia, staged segmental occlusion	Yes	Ascending to innominate, carotid to transverse, and aneurysmorrhaphy	Homologous	Fibrillation	4 hours
6 51 F	Hypothermia, staged segmental occlusion	Yes	Entire arch	Homologous	Fibrillation	2 hours
7*	Hypothermia	Yes	Distal segment	Homologous	Cardiac arrest	(Died on table)
8	Extracorporeal circulation	Yes	Entire arch and ascending aorta	Homologous	Cardiac arrest	(Died on table)
9 51 M	Hypothermia, staged segmental occlusion, 1st part complete	Yes	Ascending to innominate and carotid	Homologous	Fibrillation	(Died on table)
10 47 F	Hypothermia	No			Hemorrhage	(Died on table)
11* 27 M	Hypothermia	No			Hemorrhage	(Died on table)
12 33 M	Hypothermia	Yes			Fibrillation	2 days
13* 57 M		Inoperable			Hemorrhage, coronary occlusion	21 days
14 47 M		Yes	Ascending to right carotid and aneurysmorrhaphy	Homologous		14 days (A&W)

*Emergency.
(A&W) Alive and well.

The first of these methods was hypothermia which was used in all but 3 of the group.

The second was a staged segmental occlusion technique which we reported 2 years ago (1). This technique involved hypothermia plus a planned order of permanent shunts. A side-to-end end-to-side homologous graft was placed from the ascending aorta to the innominate artery by means of partial occlusion clamps. This permitted crossclamping distal to the shunt with subsequent grafting of the remaining arch. In 3 cases this was accomplished. A fourth patient died before the second shunt could be completed.

The third method was extracorporeal circulation. In 1 case in the group a pump oxygenator of the Gibbon type was used.

Temporary shunts of plastic tubing and bovine heterografts or homografts are considered a fourth method, but were not used in this group.

In addition to these adjunct techniques the 14 cases are also listed under elective or emergency procedures. Three were emer-

gencies because active hemorrhage was present on admission.

Homologous freeze-dried grafts were used in 8 cases, 1 of which included an aneurysmorrhaphy. Aneurysmorrhaphy was all that was needed in 2 cases. Three patients expired before the grafting stage was reached. One patient was inoperable.

Complications. In the aortic arch group there were no late complications as all 4 patients were discharged from the hospital as improved and are at present alive and well 45, 44, 30 months, and 2 weeks after operation (Table I).

There were 3 delayed complications. One which occurred 15 hours after the operation. The patient was fully reacted from anesthesia. He was alert and talkative. During a conversation with his attendant he suddenly stopped breathing and expired soon afterward from what is presumed to be an embolic phenomenon. A second patient underwent thoracotomy with mobilization of the aneurysm. At that point cardiac irregularity became so severe that it was decided to delay the grafting until a later date to allow for stabilization. Two days later the patient suddenly died from hemorrhage. At autopsy it was seen that the aneurysm had ruptured through a 5 centimeter laceration in its posterior wall. In the last case in this group an exploratory operation was performed as an emergency. The aneurysm extended from the aortic ring to the ligamentum arteriosum expanding to the apex of the left hemithorax. A slow leaking point was controlled, but the magnitude of the lesion defied resection. The patient died 21 days later from recurrent hemorrhage.

Seven cases were classified as immediate complications. Five of these patients died on the operating table and 2 died before reacting from anesthesia. Two of them underwent emergency procedures.

Uncontrollable hemorrhage occurred during dissection of the aneurysm in 2 cases. In one, the posterior wall of the lesion was dependent on the pulmonary conus; in the other, the superolateral wall of the aneurysm consisted of an abscess cavity traced to a previous dental extraction. The aneurysm had dissected distally and was leaking rapidly. Emergency exploration was necessary.

In 1 case, ventricular fibrillation occurred before completion of grafting. The lesion extended from the ascending aorta to the ligamentum arteriosum. Circulation had been established between the ascending aorta and both carotid vessels when fibrillation occurred. All attempts at resuscitation failed.

Grafting was completed in the remaining 4 cases. In 2 of these, cardiac arrest was irreversible, while in the other 2, resuscitation was temporarily effective, but the patients died in the recovery room 2 and 4 hours after operation.

DESCENDING THORACIC AORTA

There were 3 cases of aneurysm of the descending thoracic aorta. One of these extended from the left subclavian artery to the celiac axis. The remaining 2 cases involved the descending thoracic aorta alone. Atherosclerosis was the etiologic factor in each case. There were 2 true fusiform lesions and the third was a saccular aneurysm.

Treatment. In this group of cases are included the type of graft used and one of the adjunct techniques which was an aid in protecting body tissues against prolonged anoxia (Table II). A homologous and vinyon "N" graft was used in 1 case. In the other 2 cases vinyon "N" and orlon grafts were implanted. In 1 case the aorta was crossclamped for 40 minutes under normothermic conditions and again for 20 minutes without ill effect. Hypothermia was used in the other cases. Two were emergency procedures because of pain, hemorrhage, and shock.

Complications. In the descending thoracic aortic group there were 2 late complications. One occurred some months later when an aneurysm developed in a homologous graft, causing severe pain (3). The graft was excised and a vinyon "N" woven, seamless tube was used to replace it. The second patient developed sudden hemorrhage 28

TABLE II.—DESCENDING THORACIC AORTA

Case No. *Age* *Sex*	*Adjunct techniques*	*Operative dissection completed*	*Length of grafting, cm.*	*Type of graft*	*Complications*	*Survival from date of graft*
1 60 F	a. (None)	Yes	15	Homologous	Aneurysm in graft	12 months reoperated
	b. Hypothermia	Yes	17	Vinyon "N"	None	36 months (A&W)
2 46 M	a. Hypothermia	Yes	15	Vinyon "N"	Aorta ruptured below graft	28 days reoperated
	b. Hypothermia	No			Hemorrhagic shock	2 hours
3 60 M	Hypothermia	Yes	22	Orlon	Shock	2 hours

(A&W) Alive and well.

days following grafting. At exploration the graft was intact, but a rupture had occurred in the aorta distal to it. The patient died from hemorrhagic shock. One case was in the immediate complication classification. This patient had been operated upon as an emergency. The ruptured aneurysm was resected and a 22 centimeter orlon graft was implanted. The patient never recovered from the anesthesia and shock and died 2 hours later.

ABDOMINAL AORTA AND ILIAC BIFURCATION

Thirty-seven patients with acquired aortic vascular lesions of the abdominal aorta were operated on. Thirty-two of these lesions were true aneurysms, all of which were basically fusiform in type, but had saccular components superimposed. In each case one or both iliac bifurcations were involved in the disease process. Aneurysms in all cases had developed 2 centimeters or more below the origin of the renal arteries. The remaining 5 cases were of the thrombo-occlusive lesion type.

The basic etiology in this entire group was atherosclerosis, producing either dilatation with aneurysm formation on one hand or chronic progressive arteritis with eventual partial or total occlusion on the other.

Treatment. The ultimate goal in the entire group was resection with grafting of the diseased segment. However, in 2 of the 37 cases grafting was not performed. In the first of the latter 2 cases the right iliac bifurcation had formed an aneurysm above a high thigh amputation which had been performed some years before. There was no necessity for additional blood supply. The aneurysm was excised. The second case was that of sudden occlusion of the abdominal aorta 10 days after myocardial infarction and fibrillation. An embolectomy was chosen because of the poor operative risk.

Thirty-five patients had resection of the diseased aortic segment with grafting. Only 1 adjunct technique, hypothermia, was used and this in 1 case only.

In seven of these cases a thoracotomy incision had to be performed in addition to the celiotomy incision. This enabled tourniquet control of the descending thoracic aorta in these cases where adequate control was technically difficult in the abdomen. All of these were emergency procedures in which the aneurysm had ruptured.

Five types of grafts were used in the 35 cases. Thirteen were homologous arteries prepared by the freeze-dried technique. Three types of plastic material were employed: orlon, dacron, and nylon. All 3 materials were obtained in taffeta form and the bifurcation grafts were either sewed or sealed by heat(2). Nylon was also used in the commercially prepared crimped graft form. Homologous grafts were used when available. This accounts for the greatest number being used in elective cases.

Of the 35 abdominal lesions, approximately 86 per cent were aneurysms and 14

TABLE III.—ELECTIVE PROCEDURES IN ABDOMINAL AORTA AND ILIAC BIFURCATION (ANEURYSMS)

Case No. *Age* *Sex*	*Preop. findings*	*Type of graft*	*Postop. complications*	*Survival from date of graft*	*Cause of death*
1 57 M	Pain and mass 5–6 years	Homologous	None	38+ months	(A&W)
2 68 M	Mass 3 weeks	Homologous	None	20+ months	(A&W)
3 57 M	Pain and mass 3 weeks	Homologous	None	28+ months	(A&W)
4 62 M	Mass and claudication 2 years Readmitted 6 months later with mass and fever of 2 months duration	Orlon	Left iliac abscess and hemorrhage	6 months 14 hours	Hemorrhage, shock
5 49 M	Aneurysm found at operation 2 years before admission	Homologous	None	18+ months	(A&W)
6 59 M	Mass and intermittent claudication 5 years	Homologous	None	18+ months	(A&W)
7 64 M	Mass 3 months	Homologous	None	38+ months	(A&W)
8 68 F	Mass 3 months	Homologous	Thrombosis of graft 6 days later (re-explored)		Hemorrhage, shock
9 66 M	Mass 2 months	Dacron (hs)	None	9+ months	(A&W)
10 61 M	Mass and pain 7 days	Nylon crimp	None	6+ months	(A&W)
11 67 M	Aneurysm found at operation 1 year before admission	Dacron (hs)	None	8+ months	(A&W)
12 47 M	Pain and claudication	Homologous	None	16+ months	(A&W)
13 67 M	Claudication 2 years cong. failure	Nylon crimp	Ventricular fibrillation		Cardiac arrest
14 65 M	Mass 2 months	Homologous	None	6+ months	(A&W)
15 63 M	Claudication 8 years. Pain in buttocks 6 months. Abdominal mass 6 months	Nylon crimp	Thrombosis of the left anterior tibial artery	3+ months	(A&W)
16 57 M	Pain in right leg 6 months. Mass 1 month	Nylon crimp	Wound abscess	2+ months	(A&W)

(A&W) Alive and well.
(hs) Heat sealed.

per cent thrombo-occlusive disease. In the aneurysms half of the cases were emergency procedures, the others elective. Only 1 of the 5 thrombo-occlusive disease group required emergency operative intervention.

Aneurysms. The number of cases of abdominal aneurysm is large enough to divide into emergency and elective categories to facilitate discussion of complications.

In the elective group of 16 cases there were only 3 complications: 1 immediate, 1 delayed, and 1 late (Table III). The first complication was in a 67 year old male who developed ventricular fibrillation soon after

TABLE IV.—EMERGENCY PROCEDURES IN ABDOMINAL AORTA AND ILIAC BIFURCATION (ANEURYSMS)

Case No. *Age* *Sex*	*Duration of rupture*	*Simultaneous thoracotomy*	*Type of graft*	*Postop. complications*	*Survival (from date of graft)*	*Cause of death*
1 58 M	1 day	Yes	Nylon	Paraplegia, thrombosis	17 hours	Shock
2 70 F	4 days	Yes	Nylon	Cor pulmonale	35 days	Cong. failure
3 55 M	1 day	No	Orlon	L.B.B. block	2 days	Shock
4 57 M	4 days (Hypotension)	No	Orlon	Thrombosis (re-explored 2 hours later)	2 days	Shock
5 57 M	12 hours	No	Orlon	—	—	Hemorrhage
6 79 M	8 hours	Yes	Homologous	—	—	Hemorrhage
7 69 M	5 days	Yes	—	—	—	Hemorrhage
8 60 M	3 days	No	Orlon	—	16 months	(A&W)
9 56 M	1 day	No	Orlon	Shock	24 hours	Shock
10 70 M	12 hours	No	—	Peritonitis	7 days	Peritonitis
11 76 F	4 days	No	Homologous	Anuria	2 days	Shock, uremia
12 67 M	12 hours	(Hypothermia)	Nylon crimp	Thrombosis (rt. iliac) re-explored 2 hrs. later	4 days	Coronary occlusion
13 62 M	7 days	No	Nylon crimp	Shock	1 day	Shock
14 54 M	6 hours	Yes	—	Cardiac irregularity re-explored 8 hours later	—	Hemorrhage, shock
15 84 M	5 hours		Orlon	Hemorrhage and abscess	34 days	Shock
16 63 M	5 days	Yes	Homologous	Thrombosis of iliac	2 days	Hemorrhage, shock

crossclamping the aorta. Grafting was completed during cardiac resuscitation. Cardiac arrest was irreversible. The patient had been under treatment for congestive failure due to chronic arteriosclerotic cardiovascular disease. The delayed complication was thrombosis of the grafted segment. This occurred 6 days after operation. The patient was on anticoagulation therapy for 5 days and thrombosis developed 24 hours after this was discontinued. The patient was re-explored and the aorta was found to be occluded at the renal artery level. The patient expired during this procedure. The late complication was an abscess which developed in the region of the left iliac anastomosis some 4 months after grafting. Symptoms were minimal, consisting mostly of a low grade fever for 2 months, then a mass developed in the left lower quadrant

of the abdomen. Soon thereafter, the patient developed severe pain in the same region and was readmitted to the hospital in a state of shock. At re-exploration there was an abscess around the left iliac anastomosis and a large retroperitoneal hematoma. The patient died 14 hours later from hemorrhagic shock.

In the emergency group of 16 cases there were 14 complications (Table IV). Four of these were immediate, 9 delayed, and 1 late. All of these complications resulted in death.

The 4 immediate complications were irreversible hemorrhagic shock. Three of these patients were admitted to the hospital in shock and the fourth went into shock while in the hospital undergoing diagnostic studies. Three of these 4 patients required a thoracotomy to control bleeding for reasons described.

In the delayed complication group the problems were more varied. Four of these 9 cases involved thrombosis of the grafted segment. Two of these patients required re-exploration within a few hours of the initial procedure. Circulation was re-established, but 1 died of shock 2 days later and the other died of acute coronary occlusion 4 days later. The remaining 2 died of hemorrhagic shock 17 and 24 hours after operation. These 2 patients were not re-explored as adequate blood pressure levels could not be maintained. Four patients also died of hemorrhagic shock, but had no evidence of thrombosis of the graft. One of these was anuric for 4 days which contributed to death. The last patient in this group died from peritonitis 7 days after resection which injured the right ureter.

The late complication occurred in an 84 year old male who returned to the hospital 34 days following operation. On re-exploration for the causes of shock, fever, and pain, an abscess was found around the proximal anastomosis of the graft. A small leak at this point in the proximal aorta had also occurred, resulting in a large retroperitoneal hematoma. He died 24 hours later. The fifteenth patient died of a complication 35 days following operation which is not directly attributed to the procedure. This 70 year old woman had had chronic cor pulmonale and died with congestive failure.

The sixteenth patient has a good functioning graft 20 months following resection. All 16 patients at the time of operation had historical evidence of rupture with varying degrees of hemorrhage of from 5 to 168 hours' duration.

Thrombo-occlusive disease. In the 5 cases of thrombo-occlusive disease treated, there were 3 immediate complications and 1 delayed complication (Table V). Thrombosis occurred in all 3 of the immediate group. The entire graft was occluded in one, the left iliac in a second, and the left femoral artery in the third.

All 3 patients underwent re-exploration with re-establishment of circulation, but required a third procedure as well. The first 2 patients required the third operative procedure because of hemorrhage from the proximal aorta near the anastomosis. One of these died 7 days after the third procedure from thrombosis and shock complicated by gangrene of the bowel and extremities. The other died from hemorrhagic shock resulting from massive blood loss into the duodenum from the aorta. In the third case an amputation was done because of occlusion of the posterior tibial artery. The patient is alive and well 45 months after the initial procedure.

The delayed complication was that of coronary occlusion present prior to operation, but fatal 4 days postoperatively. Embolectomy of abdominal aorta was effected by re-establishment of circulation.

The fifth case is uncomplicated 12 months following resection.

DISCUSSION

After 4 years certain principles of management seem to have evolved from the experiences gained in this series of cases. The basic principles of surgery remain the same, in fact are re-emphasized, but preference for new methods can at least be stated.

TABLE V.—ABDOMINAL AORTA AND ILIAC BIFURCATION (THROMBO-OCCLUSIVE DISEASE)

Case No. *Age* *Sex*	*Em./El.*	*Duration of symptoms*	*Extent of graft*	*Type of graft*	*Complications*	*Survival (from date of graft)*	*Cause of death*
1 59 M	El.	4 years	Infrarenal both iliacs	Dacron (hs)	—	9 months	(A&W)
2 48 M	El.	6 years	I. Infrarenal both iliacs	Nylon crimp	Thrombosis of graft	50 days	—
	El.		II. Same	Dacron (hs)	Abdominal abscess	59 days	
	Em.		III. Same	Suture of aorta No. 2	Hemorrhage shock, paralysis, thrombosis of peripheral vessels	7 days	Gangrene (sigmoid) septicemia, shock
3 39 M	El.	7 months	I. Infrarenal both iliacs	Dacron (hs)	Left iliac thrombosis	17 days	
	El.		II. Same	Dacron (hs)	Thrombosis (left iliac)	29 days	
	Em.		III. —	—	Erosion into duodenum	—	Hemorrhage
4 54 F	El.	7 months	Infrarenal both iliacs	Homologous	Thrombosis (left femoral) amputation left leg 1 month later	41 months (A&W)	
5 55 M	Em.	6 months	None (embolectomy)	—	Myocardial infarction	4 days	Myocardial infarction

(hs) Heat sealed.
(A&W) Alive and well.

Aortic arch group. Vascular disease in this region remains the most formidable problem of all. Etiologic agents other than syphilis must be considered. Trauma may soon be more common than luetic aortitis.

Saccular lesions which lend themselves to aneurysmorrhaphy give the best results. Again early diagnosis with early resection is emphasized.

Hypothermia, employed routinely at first, is now questioned. The high incidence of cardiac irregularities with fatal outcome indicates normothermia with shunts or mechanical bypass to be a better technique. In addition, hypothermia adds much time to an already lengthy and exhuasting procedure for both patient and surgeon.

Homografts are still preferred over plastic prostheses in vessel replacement in this region, as expansibility and elasticity are essential to function at this point.

Descending thoracic aorta. Vascular lesions in this region are usually atherosclerotic in origin and represent only a segment of a generalized disease. The length of grafting required is often extensive. No cord paralysis was encountered in this small group, perhaps because the disease had already altered the intercostal circulation. Although hypothermia was used in most cases, the aorta was crossclamped for 40 minutes without hypothermia and without complications.

Plastic blood vessels lend themselves naturally to this region because of the straight tube without branches. One patient with a vinyon "N" prosthesis has been asymptomatic for 3 years.

Abdominal aneurysms. Aneurysms below the diaphragm were twice as frequent as those above. The average age incidence was 62.5 years, the youngest being 47 and the oldest 84. Sex ratio was 10 males to 1 female. All originated in atherosclerotic disease.

The most striking feature of this group consists of the results when divided into elective and emergency categories. The surgical mortality in the elective group was 12.5 per cent whereas the mortality in the emergency group was 81.2 per cent. The emergency series on admission to the hospi-

tal all presented evidence of rupture of the aneurysm with varying degrees of hemorrhage. The duration of symptoms indicating rupture varied from 5 to 168 hours.

No patient was denied exploration because of age or concomitant disease such as renal failure or chronic arteriosclerotic cardiovascular disease. Frequently, the rapidity of blood loss in patients with ruptures was so great that it was necessary to start the operation with the patient in profound shock. In these cases despite multiple rapid transfusions of blood the blood pressure could not be maintained until the aorta was crossclamped. In 7 cases the hemorrhage was so extensive that the most rapid method of control was through a low left thoracotomy. One of the 3 survivors in the emergency group was treated in this manner.

The large number of exceptionally poor risk patients in the emergency category accounts for the high mortality rate. It is indeed surprising that the salvage was as high as 18.8 per cent.

Abdominal thrombo-occlusive disease. The average age incidence in this group was 51 years. All were male patients. Originally this lesion was considered more suitable for grafting as collateral circulation was established. However, the high incidence of thrombus formation in the grafted segments has raised the question as to whether or not there is some basic defect in the clotting mechanism in these patients. Half of this small group required subsequent operations to remove clots despite the use of anticoagulant therapy during the initial procedure.

In general, the type of graft employed in the abdomen had no relation to the complication as thrombosis occurred in homologous, orlon, nylon, and dacron prostheses.

In the abdominal resections anticoagulant solution was routinely employed, being instilled above and below the points of crossclamping. Despite this preventive measure, in 8 cases thrombosis occurred in the graft after closing the abdominal incision.

Anticoagulants were continued postoperatively in 3 cases. In 2 of these intra-abdominal hemorrhage developed requiring emergency transfusions. The third patient was maintained for 5 days on heparin without mishap, then a massive thrombus developed from the renal arteries to the femoral arteries 24 hours after the drug was discontinued.

SUMMARY

1. Fifty-three unselected, consecutive cases of acquired aortic vascular diseases were treated surgically over the past 4 years.

2. These cases are discussed as to anatomic location, type of lesion, etiology, method of treatment, and the complications which followed.

3. Selection of adjunct surgical techniques including hypothermia, staged segmental occlusion with shunts, and extracorporeal circulation is listed.

4. Lesions in the aortic arch remain the most formidable of all locations. Saccular aneurysms which lend themselves to aneurysmorrhaphy give the best results.

5. Descending thoracic aortic disease is usually atherosclerotic in origin and represents only a segment of generalized disease. Often long vessel segments must be grafted.

6. Abdominal aneurysms were twice as frequent as thoracic aneurysms.

7. The striking difference in the mortality of elective procedures versus that of emergency operations is evaluated.

8. Type of blood vessel prosthesis is considered for each of the 3 anatomic locations.

9. Thrombosis as a complication in abdominal grafts occurred more frequently in thrombo-occlusive disease than in aneurysmal lesions.

10. The importance of early diagnosis and surgical treatment is re-emphasized.

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A NEW LOOK AT PULMONARY EMBOLECTOMY

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IN 1908 TRENDELENBURG first proposed the possibility of performing embolectomy for massive pulmonary embolism. He referred to 9 patients who had died in Leipzig from this cause. Two had succumbed suddenly, but the other 7 survived for intervals varying between 10 and 60 minutes. He reasoned that during such intervals some attempt at surgical therapy could be made. He successfully operated upon a calf in which a pulmonary embolus had been artificially produced. He developed the operative technique for humans in the autopsy room. Three pulmonary embolectomies were performed by him on humans but none was successful in producing complete recovery. Although 2 patients survived the operation, one died 16 hours later of heart failure and the other in 37 hours of hemorrhage from the internal mammary artery. He had, however, demonstrated the procedure to be a feasible one.

In 1924 Kirschner performed the first pulmonary embolectomy to be followed by complete recovery. The procedure soon thereafter became popular both in Europe and in the United States. The medical literature of the period between 1920 and 1940 contains many reviews of the subject with reports of many unsuccessful, and a few successful, cases. Since that era the operation appears to have been seldom performed. The European literature has been the sole source of any reference to pulmonary embolectomy for about two decades.

At the Peter Bent Brigham Hospital in January 1958 an embolectomy for massive pulmonary embolism was successfully performed on a 65 year old woman. She has been discharged from the hospital well. This result has stimulated us to review the subject in order to outline current indications for the procedure as they have evolved from past and present surgical attitudes.

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REVIEW OF THE LITERATURE

The reported cases of pulmonary arteriotomy can be arranged in three major groups with respect to the degree of success of the procedure.

Group 1. This comprises those patients suffering massive pulmonary embolism in whom embolectomy was performed, and who were discharged well from the hospital. A massive pulmonary embolism is taken to mean one which produces such severe cardiovascular impairment as to cause sustained hypotension or sustained impairment of function of vital centers. Until the present case there has been no successful embolectomy reported in the United States.

Year	*Surgeon*	*Country*
1924	Kirschner	Germany
1927	Meyer (9)	Germany
1927	Crafoord (1, 3)	Sweden
1928	Meyer (10)	Germany
1928	Nystrom	Sweden
1928	Crafoord (1, 3)	Sweden
1929	Nystrom	Sweden
1931	Meyer (10)	Germany
1933	Crafoord (1)	Sweden
1935	Valdoni	Italy
1939	Lewis	Great Britain
1952	Marion	France
1958	Peter Bent Brigham Hospital	United States

There is 1 further case reported by Vandecasteele in 1955 which should be mentioned in this group. The patient suffered multiple small pulmonary emboli over a period of 2 months none of which was life-endangering. Because of the progressive development of right-sided heart failure she

was transferred to another city by ambulance and pulmonary embolectomy was carried out. Two small ("coffee spoon sized") emboli were removed, and ligation of the inferior vena cava was performed. She survived the procedure and left the hospital well. A "massive" pulmonary embolism had, however, not occurred. Hence the indications for operation under the clinical conditions outlined were quite different from those under current discussion.

Group 2. This consists of those patients who suffered massive pulmonary embolism in whom embolectomy was performed and who made good recovery from the operative episode but died of complications of the procedure or of recurrent emboli. Since there may be many such cases which have not been reported the degree of completeness of this group is uncertain. The definition of recovery from a single episode, furthermore, is subject to varying interpretations. We have not included in this group, for instance, a patient operated upon in 1934 at the Peter Bent Brigham Hospital who lived for 2 hours and then died of what was thought to be recurrent embolism, although no autopsy was performed.

Year	*Surgeon*	*Cause of death*	*Length of survival*
1908	Trendelenburg	Internal mammary artery hemorrhage	37 hours
1909	Kruger (7)	Mediastinal sepsis	5¼ days
1914	Schumacher (18)	Recurrent pulmonary embolus	50 hours
1927	Meyer (9)	Recurrent pulmonary embolus	25 days
1927	Nystrom	Recurrent pulmonary embolus	30 hours
1930	Crafoord (1)	Mediastinal sepsis	7½ days
1931	Westerborn	Recurrent pulmonary embolus	24 hours
1945	Nicole	Recurrent pulmonary embolus	2½ weeks

The danger of recurrent massive pulmonary embolism is impressively real in this group.

Group 3. This is a mixed group of patients who either underwent a pulmonary arteriotomy at which no embolism was found or failed to survive the operation despite the removal of an embolus. Many of them have never been reported. The experience of our hospital will serve as a sample.

In the 45 years since the Peter Bent Brigham Hospital was founded 14 patients were operated upon prior to the case currently reported. The operations were all done in the decade 1933 to 1943 as a result of the stimulus toward its performance then provided by Elliott C. Cutler. All patients died, the longest survival being 2 hours. Large clots were removed from the pulmonary artery in 11. In the 3 in whom no clots were found 1 showed many small clots at autopsy, 1 was not autopsied, and in 1 only, a patient dying of cerebral embolism and pericarditis, was the diagnosis proved to have been incorrectly made. The time intervals from the embolus to operation varied from 5 minutes to 2 hours. In 7 of the 14 the heart was not beating when the thorax was entered. In 6 of the other 7 the heart stopped or went into ventricular fibrillation during the manipulation attendant on removal of the clot. In them the heart could not be started again. In only 1 did normal cardiac action proceed throughout the operation. This patient lived 2 hours in a hypotensive state and died from either myocardial failure or a fresh embolism. No autopsy was obtained.

CASE REPORT

F. S., aged 64 years, female, was admitted to the hospital on December 29, 1957, and discharged on March 10, 1958. On admission the history and physical examination were compatible with acute cholecystitis. Evaluation of her general condition revealed no significant abnormalities other than those associated with this diagnosis and early operation was planned. This was delayed, however, by the development of signs of acute pharyngitis from which beta hemolytic streptococcus was cultured and which was associated with a temperature elevation to 102 degrees F. It was treated with antibiotics.

On January 8, 1958 cholecystectomy and choledochostomy were accomplished uneventfully. At operation subsiding acute cholecystitis was found. The gallbladder contained many small calculi, but the common duct revealed none. For the first 6 days her postoperative convalescence was uneventful. The temperature was elevated to 100.8 degrees F. on the first day following operation but remained within

the normal range thereafter. There was no elevation of pulse, and repeated examinations of the lower extremities aroused no suspicion of thrombophlebitis. She was ambulatory from the first day.

At 3:30 in the afternoon of the sixth postoperative day, the patient experienced a syncopal attack while walking in the ward. She was immediately replaced in her bed. Her blood pressure was unobtainable. The peripheral pulse was thready and rapid. Within 4 minutes the systolic pressure returned to 90 millimeters of mercury. The patient was responsive but uncomplaining. Examination of the chest revealed scattered rales in both bases. Neck veins were not observed to be distended. An electrocardiogram was taken immediately and revealed the development of right bundle branch block (Fig. 1). The clinical diagnosis of pulmonary embolism seemed evident. The administration of oxygen was begun via nasal catheter. Systolic blood pressure remained at 90 millimeters of mercury for 10 minutes, then disappeared, and was thereafter unobtainable.

She was moved in bed to the operating room while oxygen therapy was continued. An electrocardiogram revealed a continuous pattern of cardiac activity with no essential change from the initial observation. After 10 minutes' observation in the operating room, during which time sterile instruments were readied for embolectomy, operation was begun. Forty-five minutes had elapsed since the initial episode and 25 minutes since the blood pressure had been last obtainable.

Through a left parasternal incision, extended laterally in the submammary fold, the first 5 left costal cartilages were exposed anteriorly, transected, and retracted. On opening the pericardium the right ventricle was seen to be greatly dilated, but irregular feeble systolic contractions were observed. Two tapes were passed through the transverse sinus in order to obtain proximal and distal control of the pulmonary artery and aorta. The pulmonary artery was then opened anteriorly through a 2.5 centimeter longitudinal incision. Despite dilatation of the right side of the heart, cardiac action was so weak that blood loss from the arteriotomy, though brisk, was not massive nor sustained. Exploration through the opening with a sponge forceps, first into the left and then into the right pulmonary artery, produced, on one of the passes, 2 large clots which had been lodged in the right main pulmonary artery (Fig. 2). None was procured from the left. After these emboli were removed the arteriotomy was controlled by a partially occluding clamp and then closed with a running silk suture. The emboli were removed approximately 55 minutes from the first sign of pulmonary embolism.

As the pulmonary artery was closed, spontaneous ventricular contraction ceased and manual systole was begun. The dilated atonic ventricle rapidly regained its tone. Ventricular tachycardia and then fibrillation ensued. Defibrillation and arrest were effected by an electrical impulse and manual systole was resumed. Some spontaneous ventricular contractions started at once, but intermittent manual assistance was necessary for another 30 minutes. By the time closure of the chest was begun, a systolic pressure of 90 millimeters of mercury was audible. No anesthetic agent had been required throughout the procedure. At the termination of wound closure the patient was moving spontaneously. One thousand cubic centimeters of blood were given during the operation.

Postoperatively the systolic blood pressure ranged between 100 and 110 millimeters of mercury. The patient was immediately responsive to questioning. Repeat electrocardiogram 2 hours after embolectomy revealed disappearance of the cor pulmonale. Five hours after the procedure she was returned to the operating room where bilateral common femoral vein interruption was accomplished under local anesthesia. No clot was found in the veins at the level of division. During the next few hours the blood pressure again fell gradually. An intravenous infusion of norepinephrine was begun. By the following morning the blood pressure was well maintained with norepinephrine, but urine output was small. The patient had developed a combined respiratory and metabolic acidosis as revealed by the following studies on arterial bloods: pCO_2 52 mm. Hg, total CO_2 23 mM./L., HCO_3^- 22mM./L., pH 7.26. Neither the correction of the acidosis nor the rapid infusion of 500 cubic centimeters of blood allowed for adequate maintenance of blood pressure without vasopressor drugs. Accordingly, 24 hours after operation, the patient was rapidly digitalized with intravenous digoxin. Cardiac outputs were measured by Richard Gorlin before and after digitalis by a direct recording precordial surface scintillation technique, in which an intravenous injection of radioactive iodinated albumin was used as a tracer substance. The cardiac output prior to digitalization was 4.0 liters per minute, and 4 hours after 1.5 milligrams of digoxin was 7.0 liters per minute.

A salutory response was immediately apparent. Blood pressure was now maintained at levels of 110/60, the pulse at 76, and vasopressor drugs were discontinued. Urine output immediately increased to normal. The patient was more responsive. Electrocardiogram taken on the second postoperative morning showed a pattern of posterior myocardial infarction. Neurologic examination now revealed mild right-sided weakness with hyperreflexia. During the ensuing 13 days, the recovery was marked by no further untoward events. Maintenance digitalis was continued. There was a gradual resumption of oral feeding and of ambulation.

Her convalescence was interrupted on the fourteenth postoperative day by a sudden occlusion of the left femoral artery in the femoral triangle. Her extremity, although temporarily affected, never showed signs of dangerous ischemia and soon became asymptomatic, so surgical embolectomy was withheld.

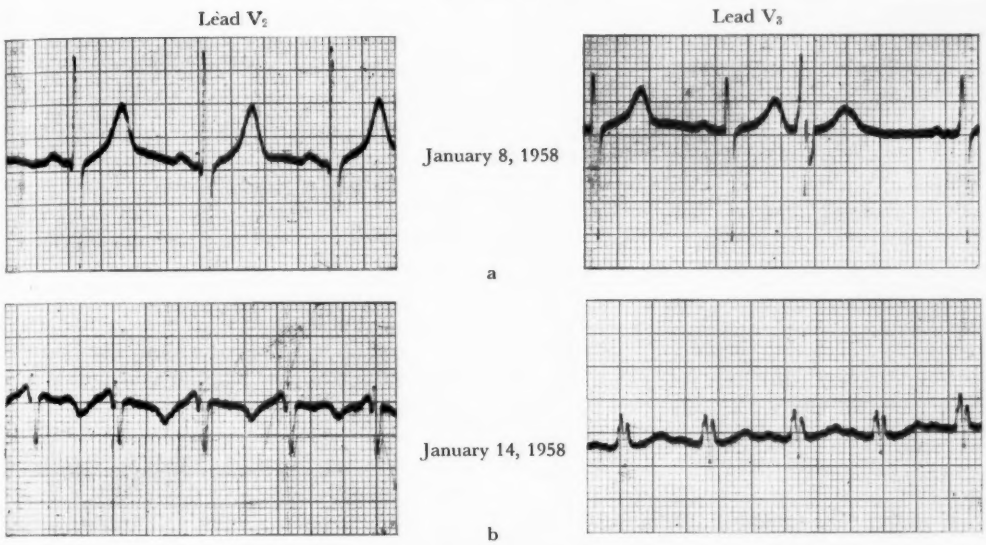

FIG. 1. Electrocardiographic tracings: a, Routine tracing before cholecystectomy. Rate 60. Occasional auricular premature beats with aberrant ventricular conduction. b, Tracing taken just after massive pulmonary embolism. Rate 110. There is development of tachycardia and the typical broadening and configuration of the QRS complex with a very marked RSR^1 in V_2 and V_3 diagnostic of right bundle branch block which are suggestive of acute cor pulmonale.

At the time of discharge from the hospital 10 weeks after her admission and 8 weeks after pulmonary embolectomy, she was well except for minor disability. The right hemiparesis was evidenced only by slight ataxia of the upper extremity and was continuing to improve. She had an area in the lower end of her thoracotomy wound which had not yet quite healed. Anticoagulants and digitalis had been discontinued 1 month and 6 weeks respectively after the pulmonary embolectomy.

She returned to the hospital 1 week later because of iliofemoral thrombophlebitis in the right lower extremity. There was swelling of both thigh and calf and tenderness in the right iliac fossa. She was treated successfully with anticoagulants, first with heparin and then dicumarol. The latter has been continued since. She did not develop signs of pulmonary embolism, and she has remained well since her second discharge from the hospital, which occurred 10 days after admission.

DISCUSSION

There were two reasons for the abandonment of attempts at pulmonary embolectomy around 1940. The first was the aura of discouragement which surrounded previous unsuccessful attempts. The second was the promise of a more basic attack on the disease afforded by the advent of the anticoagulant drugs. In 1944 Ochsner made the statement, "I hope we will not have any more papers on the removal of pulmonary emboli before this organization [The American Surgical Association], an operation which should be of historic interest only. Certainly the way to prevent death from pulmonary embolism is to prevent the clot from becoming detached and getting into the pulmonary artery if thrombosis does occur." It is unfortunate that the high hopes held out for the anticoagulants as expressed in these words have not been entirely borne out. At the Peter Bent Brigham Hospital we continue to see about 5 major massive pulmonary embolisms per year on a surgical service performing 2,500 operations annually (4), and even in areas where widespread prophylactic use of the anticoagulants has been made postoperatively the accident has not been eliminated, as shown by Roe and Goldthwait.

DIAGNOSIS

That the diagnosis can be correctly made in most cases is demonstrated by the report of Benichoux on Crafoord's cases in which the proper diagnosis was made in each one of the 22 cases. In the Peter Bent Brigham Hospital series the diagnosis was made correctly in at least 11 of the 14 patients operated upon.

Once a sudden episode has occurred there are 3 major diagnostic points on which to concentrate, the distended neck veins, the electrocardiographic finding of acute cor pulmonale, and the elimination of other diagnoses. Among the latter should be mentioned myocardial failure, massive sepsis, hemorrhage, and acute electrolyte imbalance.

In the patient under consideration the electrocardiographic findings were striking and characteristic (Fig. 1). The promptness with which the examination was obtained was of prime importance.

FEASIBILITY OF THE PROCEDURE

If, in the interests of diagnosis and transportation to the operating room, one accepts that a minimum of 15 minutes are necessary between embolus and operation, it is probable that between 20 and 30 per cent of massive embolisms are amenable to surgery. This in our hospital would mean about 1 a year. The reported patient presented favorable features in this respect in that she still possessed a measure of respiratory and cardiac function (in spite of the fact that no blood pressure was obtainable and she was cyanotic and gasping) 45 minutes after the episode.

Benichoux in 1951 said, "Pulmonary embolectomy still has a place in selected cases of pulmonary embolism and recent advances in vascular and thoracic surgery are of great assistance in such operations." He made this statement in the middle of an era in which the operation had been largely abandoned for reasons which have been suggested. It is indeed strange that a modern revival of the operation has not taken place. The experience of the last 15 years with cardiac surgery has taught surgeons and anesthesiologists techniques of resuscitation which should make for a higher success rate in those patients in whom a Trendelenburg operation has been technically successful. In all of Benichoux's patients whose hearts were beating at the time of thoracotomy, cardiac arrest developed during the procedure. This was also true of 6 of the 7 patients in the earlier Peter Bent Brigham Hospital group in which the heart was beating at the time of thoracotomy and was so in the patient here reported. The number of earlier patients in whom ventricular fibrillation developed prior to standstill is unknown. The gross appearance of this arrhythmia was as unfamiliar to the surgeon of 20 years ago as was the means of arresting it and of proceeding with resuscitation following the arrest.

Intratracheal anesthesia, antibiotics, a better availability of electrocardiography, and the cardiac defibrillator all contributed to the successful management of our patient. The concept of vein interruption in the prevention of a second embolism is also of about the same vintage and was added here. We should have preferred a vena cava ligation to common femoral vein ligation, but the patient was too ill and the body habitus too obese for it to have been a wise move.

Factors of proximity and communication were favorable for success. The operating room was open; the interested surgeons were available; and the episode occurred on a ward which was on the same floor as the operating room so that transportation of the patient was independent of elevators. (This points up a persistent advantage of the old-fashioned pavilion type of hospital architecture over the more modern skyscraper type.) The patient continued to breathe spontaneously up until the time of embolectomy 45 minutes after the onset of symptoms, thus affording ample time for sterilization of an operating kit and preparation of the skin.

TECHNICAL CONSIDERATIONS

The technique of Trendelenburg, modified by Meyer (9, 10) was followed. Critical re-evaluation of the technical features of our procedure, however, has convinced us that certain alterations should be made in future cases. Here the incision was parasternal through the costal cartilages on the left. It is recommended that a sternum-splitting incision or a transverse sternal approach be used. Exposure would be quicker and better. Fear of entering the pleura is today unfounded. It is now difficult to recapture the attitude toward this feature which prompted each previous article on technique to emphasize the avoidance of the pleurae as one of the main prerequisites of success.

A tape was passed through the transverse sinus in order to procure partial proximal and distal control of the pulmonary arteriotomy. In retrospect we have considered this to have been unnecessary. A simple arteriotomy of the pulmonary artery using the finger to seal the opening in the interval between passes with the forceps and application of the partially occluding clamp should be sufficient. The clot was extracted with sponge forceps. Stone forceps or placenta forceps would be equally satisfactory.

CARDIAC MANAGEMENT

The recurrent dilatation of the right side of the heart following embolectomy and closure of the pulmonary arteriotomy could have been due either to incomplete removal of clot or right ventricular failure from overdistention. Massage was necessary to empty the right ventricle. It was followed by ventricular fibrillation, which was successfully stopped with electric shock. Normal rhythm spontaneously resumed after another 30 minutes of intermittent manual systole.

The patient showed electrocardiographic signs of acute myocardial infarction following the procedure. Whether this was the result of heart muscle damage from manipulation and electric shock or whether it was an infarct is not known. The embolus to the femoral artery which occurred 14 days postoperatively presumably arose as a mural thrombus on the left side of the heart and supports the diagnosis of infarct.

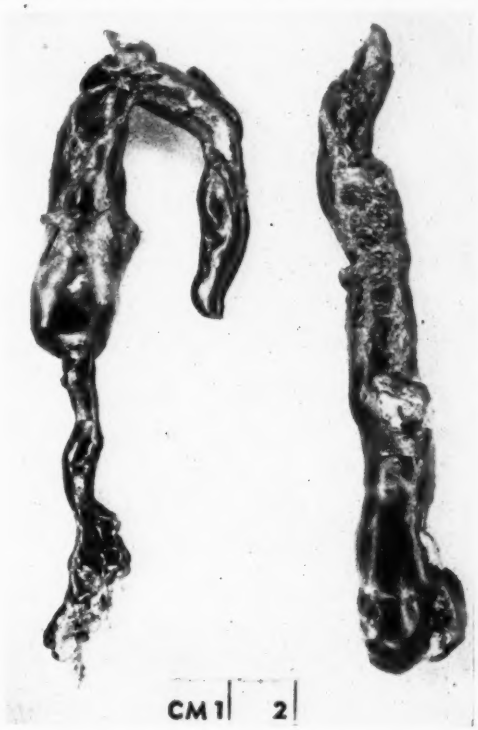

FIG. 2. Photograph of the clots removed from the right pulmonary artery.

No cardiac stimulants other than norepinephrine were used in our patient until digitalis was given 24 hours after operation at the time when it became apparent that the patient was still unable to sustain normal blood pressure without vasopressor drugs. This seemed to be the most important turning point in the convalescent phase of the patient.

On reviewing the previous Peter Bent Brigham Hospital experience with the procedure it is considered likely that at least 4 of the 7 patients whose hearts were beating at the time of the operation would have survived in the light of present-day management of the resuscitative problems which these patients present.

The possibility that this patient might have survived without benefit of pulmonary embolectomy cannot be denied, despite the fact that the blood pressure could not be detected and the patient was gasping at the time of the procedure. The case has taught us, however, that although we should be wary of operating on a patient in whom the diagnosis may be incorrect, we must consider that we have reached a stage of progress where, once the diagnosis has been confidently made, we should be permitted to perform the operation without waiting until we are sure that the patient will not survive without it. The attitude, as described by Churchill, which in the past prompted one operating team to remain alerted for 17 hours following embolism, to operate only as the patient finally died, should be a thing of the past.

SUMMARY AND CONCLUSION

1. A case of embolectomy for massive pulmonary embolism followed by survival and discharge of the patient from the hospital is reported.

2. All aspects of the case were favorable for the procedure. It is believed that although such a propitious combination of circumstances will not often be encountered the operation should be more frequently used than has been the case in recent years.

3. Patients without major complicating diseases who live long enough (15 minutes or more) so that a reasonably certain diagnosis can be made should be considered as candidates.

4. It is recommended that all patients in whom the diagnosis is suspected be taken to the operating room where, rather than on the ward, the diagnostic steps should be undertaken and the final decision for or against surgery be made. When the diagnosis is sure, and the embolus is of a size to cause sustained circulatory embarrassment, operation should be undertaken without waiting for the agonal phase.

5. Except for the last point these recommendations are not different from those made 30 years ago. Modern experience with the management of cardiac arrest and resuscitation was responsible for the survival of this patient and should be used to advantage in others. The addition of interruption of major veins to prevent further embolism is a feature of the management which should not be neglected.

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EXPERIMENTAL PRODUCTION OF PSEUDOCYSTS OF THE PANCREAS OF THE DOG

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THE ETIOLOGY of pancreatic pseudocysts has been problematic since they were first described. Pseudocysts of the pancreas are by definition fluid cavities surrounded by an inflammatory membrane; they are not lined by epithelium and communicate at some time with the pancreatic ductal system; they develop most commonly after trauma or pancreatitis. The inability in the past consistently to produce experimental pseudocysts of the pancreas has been an obstacle in the evaluation of therapeutic approach. In the present study an attempt was made to produce pseudocysts of the pancreas in the dog by a variety of methods. A method for their production was developed and the etiology elucidated. It is hoped that with a clearer understanding of etiologic factors, a more rational therapy can be planned for the individual patient.

HISTORY

Le Dentu, in 1862, stated that cysts of the pancreas should be "relegated to the list of affections for which the healing aid is impotent." Von Ziemssen, 12 years later, advised that the treatment of cysts and pseudocysts of the pancreas must be only of the symptoms as they arise. He stated that "cysts" generally result from a retention of secretions and subsequent dilatation of the duct. It is clear that he included pseudocysts in his clinical observations but apparently failed to appreciate the distinction from true pancreatic cysts.

Senn, in 1886, disproved the theory of that time that pancreatic pseudocysts were produced by common bile duct obstruction alone. He was unable in any case to produce pseudocysts by complete and permanent obstruction of the pancreatic duct. He wrote, "The important etiologic factor in cases of cysts of the pancreas must be sought in an arrest of absorption of pancreatic juice . . . ."

Thiroloix produced a pancreatic "cyst" containing clear fluid and hard irregular calculi in the dog. This was accomplished by ligating the accessory duct and injecting soot and phenolized petroleum into the duct of Wirsung. Lazarus, in 1904, crushed the pancreas in dogs producing hematomas and, in 1 instance, 6 weeks postoperatively, a "cyst the size of a goose egg" containing a white milky fluid was found. Binet and Brocq found that by injecting calcium chloride into the duct of Wirsung in dogs they could produce an acute hemorrhagic pancreatitis with fat necrosis. In 1 instance a small cyst was found but no mention was made as to the amount or character of the fluid or the nature of the cyst wall. In none of these studies were pseudocysts produced consistently or in such a manner as to permit analysis of etiology.

Doubilet and Mulholland (2, 3) reported their clinical impression in 1953 that pseudocysts developed secondary to processes in the pancreas involving one or more ducts. They postulated that a collection of pancreatic juice, blood, necrotic tissue, and inflammatory exudate is formed. This accumulation is surrounded by an inflammatory membrane. Communication with the pancreatic ductal system leading to secretion into this cavity then results in and maintains a pancreatic pseudocyst. They suggested that re-

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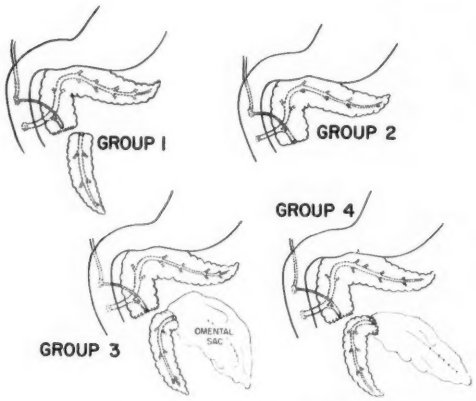

FIG. 1. Summary of the operative techniques for pseudocyst formation utilized in groups 1, 2, 3, and 4.

sistance, due to partial obstruction at the sphincter of Oddi, increases the secretory pressure into the pseudocyst. The size of the cyst therefore depends in a large measure upon the secretory pressure. They advocated treatment by sphincterotomy on this basis. Jackson and Howard attempted to create pseudocysts in 38 dogs by the following procedures: division and ligation of the pancreatic ducts, incision of the ducts, injection of blood, injection of bile, pancreatic juice, and a sclerosing agent into the major duct. None of these techniques were successful in producing pseudocysts. More recently Warren, Marsh, and Muller produced pseudocysts by a two stage procedure diverting all pancreatic secretion into a preformed fibrous cavity. Large lesions resulted but this useful technique is not suitable for analysis of pathogenesis.

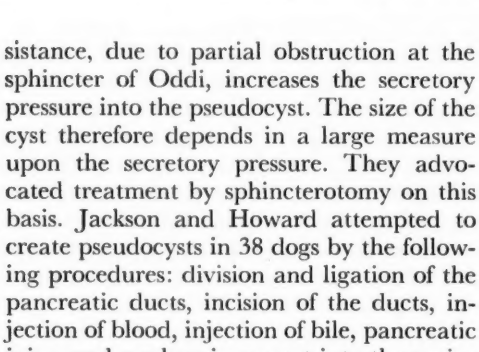

FIG. 2. Summary of the techniques utilized in groups 5, 6, and 7.

The definition of a pseudocyst includes the presence of an inflammatory membrane and a ductal communication at some time in its history. In addition, the concept of back secretory pressure due to obstruction seems logical and is supported by clinical observations. It was decided, therefore, to evaluate these factors, alone and also in combination, and to seek a method for the consistent production of pancreatic pseudocysts.

EXPERIMENTATION

Fifty-four adult mongrel dogs of either sex, weight above 15 kilograms, were used for the study. They were maintained preoperatively on a standard kennel diet. No special preoperative preparation was employed except fasting for 12 hours before surgery. In most instances, an intramuscular injection of 2.5 milligrams of bethanecol chloride (urecholine) was given just prior to the anesthesia in order to stimulate pancreatic secretion and produce a dilated pancreatic ductal system. Sodium pentobarbital, 30 milligrams per kilogram intravenously, was used for anesthesia. Blood for serum amylase determinations was drawn prior to the administration of bethanecol or anesthesia and daily serum amylase levels were determined postoperatively for 7 to 10 days.

The dogs were given a daily injection of bethanecol chloride (urecholine) in 2.5 to 5 milligram amounts postoperatively and were fed as high a meat diet as was tolerated, beginning on the first postoperative day. Antibiotics were not used.

An upper midline incision was used in all operations. The wounds were closed with No. 00 silk for the fascial layer and No. 00 chromic gut subcuticularly.

Seven basic patterns of surgical manipulation of the canine pancreas were used.

Group 1 (Fig. 1). The pancreas was completely transected in the area corresponding to the base of uncinate process about 6 centimeters from its tip. The divided blood vessels were ligated, care being taken not to include the pancreatic duct or to jeopardize blood supply. The proximal end was carefully closed. The distal end constituted an open ductal fistula which permitted drainage from the uncinate into the peritoneal cavity.

In this group of 4 dogs, 1 expired of intra-abdominal hemorrhage. In the 3 surviving dogs no evidence of pseudocyst formation was observed (Fig. 1). These animals did not appear ill following surgery and ate normally. The average daily amylase value increased, a mean of approximately 200 units from a preoperative mean of 1,000 units.

Group 2 (Fig. 1). The pancreas was transected as in group 1, but in this series the uncinate process was removed and the proximal cut end of the pancreas was left open to enable drainage into the peritoneal cavity.

There were no deaths postoperatively in the 4 dogs of this group. Their postoperative course was uninterruptedly satisfactory. Serum amylase values were unchanged and food intake was normal after the first day. The residual pancreas was normal. No pseudocysts developed.

Group 3 (Fig. 1). The pancreas was divided in the same manner as previously, but the distal portion of the uncinate process was freed from its duodenal attachment, preserving the blood supply. The proximal divided end was carefully closed. A sac of omentum with its blood supply intact was then sutured loosely around the isolated portion of the uncinate process (Fig. 3). In this manner, therefore, a closed serosal space was formed with the open uncinate duct draining into it with no other route of egress.

This group consisted of 12 dogs. Two animals of this group expired with evidence of early acute pancreatitis. In 7 of the 10 survivors a pseudocyst was found, the volume of which varied from 5 to 40 cubic centimeters. The contained fluid was dark pink to brown in color and had a variably thick consistency. Enzyme analysis of the fluid showed transaminase values as high as 1,500 units, and amylase values ranging from 4,000 to 40,000 units. The average daily serum amylase value increased to approximately 2,000 units (per 100 c.c.) from a normal value of 1,000 units. These dogs did not appear ill, were normally active, and their food intake was essentially normal. There were early atrophic changes in the detached uncinate.

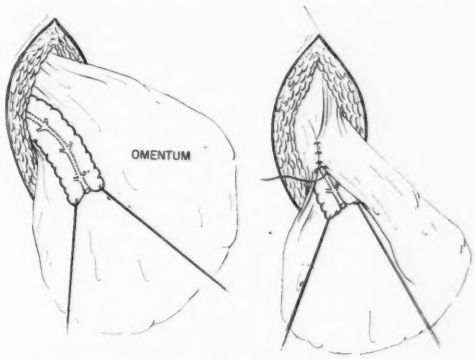

FIG. 3. Method for constructing omental pouch. The transected unicate process is mobilized. A pedicle omental flap is sutured to form a pouch, the neck of which is closed about the uncinate.

Group 4 (Fig. 1). The animals of this series were prepared identically to those of group 3 except that the divided duct of the distal uncinate process was carefully ligated. The uncinate was then placed in an omental sac (Fig. 3) as in group 3.

There were no operative deaths in this group of 4 dogs. No pseudocysts were found The detached uncinate was frankly atrophic. The postoperative course was uneventful. No significant elevation of serum amylase was detected.

Group 5 (Fig. 2). The pancreas was divided as before, and the distal portion of the divided uncinate process was completely excised. The open proximal end of the pancreas was then placed into an omental sac

PSEUDOCYST FORMATION

RESULTS

GROUP	TOTAL	EXPIRED	PSEUDOCYSTS	PANCREAS
1	4	1	0	NORMAL
2	4	0	0	NORMAL
3	12	2	7	ATROPHIC
4	4	0	0	ATROPHIC
5	6	0	0	NORMAL
6	12	8	1	ATROPHIC
7	12	1	7	NORMAL

FIG. 4. Summary of experimental results in terms of pseudocyst production.

prepared as previously described in the foregoing.

There were 6 dogs in this group. There were no postoperative deaths and no pseudocysts were formed. All dogs appeared normal following surgery and took their normal daily rations. The average daily amylase value increased transiently to a mean of approximately 3,000 units for several days compared with a mean preoperative value of 1,000 units.

Group 6 (Fig. 2). The operative manipulations were the same as they were in group 5 except that, in addition, the main pancreatic duct (Santorini in the dog) was doubly ligated and divided at the duodenum. The minor duct (Wirsung), entering the duodenum with the common bile duct, and any accessory ducts present were not disturbed.

Eight of the 12 dogs in this group expired immediately after operation with acute severe pancreatitis, usually on the first or second day following surgery. Of the 4 survivors, 1 developed a small cyst which contained about 3 cubic centimeters of a thick dark brown fluid. At the end of a 7 day period the omentum was found to be tightly attached over the cut end of the pancreas. The pancreas was markedly indurated and shrunken, resembling an atrophic pancreatitis. The course in all dogs in this group was unsatisfactory. They were inactive, lethargic, and refused their food. The average serum amylase values increased to a mean of 4,000 units from a normal mean of approximately 1,000 units.

Group 7 (Fig. 2). In this group the major pancreatic duct (Santorini) was only partially obstructed by a silk ligature. All other conditions were the same as in group 6. The time arbitrarily selected to explore the dog for the presence of a pseudocyst was 7 to 10 days after surgery. This time interval was used because in no instance did a cyst develop which was not demonstrated within 7 days.

In the dogs in which pseudocysts occurred, transaminase values of the glutamic oxalacetic type were determined spectrophotometrically.

There were 12 dogs in this group. One dog expired of postoperative acute pancreatitis. Of the 11 surviving dogs, in 7 pseudocysts developed. The largest of these contained approximately 175 cubic centimeters of a moderately pink, semitranslucent, thick fluid (Fig. 5). The pancreas itself in these dogs showed evidence of only mild induration and was not shrunken or atrophic. It was apparently an actively secreting gland. The average daily serum amylase values for these dogs was much higher than in any preceding group and, in fact, reached a mean level of over 7,000 units. These dogs did not appear ill and ate an adequate diet. In the 4 dogs in this group in which cysts did not develop the omentum was adherent over the proximal cut end of the pancreas and dilated accessory pancreatic ducts were demonstrated in each dog.

One of the pseudocysts produced in the last group (group 7) was demonstrated roentgenologically by cannulation of the main pancreatic duct and injection of contrast material (35 per cent diodrast) (Fig. 6). Histologic studies of the wall of the pseudocysts demonstrated a typical inflammatory membrane with round cell infiltration and a varying degree of organization proportional to the duration of the cyst.

There was no evidence of an epithelial lining.

Enzyme analysis of the pseudocyst fluid was compared with that of pure pancreatic juice from another dog and with that of fluid obtained from a sterile turpentine abscess from still another animal. Pure pancreatic juice yielded strikingly high amylase levels but no transaminase content. The pseudocyst fluid contained both of these enzymes at high levels. Fluid from the sterile abscess had significant amounts of transaminase, but no amylase content.

FIG. 5. Large pseudocyst in group 7 animal.

CONCLUSIONS (FIG. 4)

In considering the significance of the present experiments it would seem necessary that the term pseudocyst of the pancreas be referred to a very specific lesion. In the past there has been some lack of clarity in this regard. Pseudocyst of the pancreas is meant to include only those cystic lesions associated with the pancreas, which are not lined by epithelium and to which there is, or has at some time been, a communication from the cyst cavity to the pancreatic ductal system. Lesions of this type would appear to comprise the very large majority of the group of lesions termed "pancreatic cysts and pseudocysts."

Histologic examination of human specimens removed at surgery and autopsy indicates that the walls of pseudocystic lesions are comprised of an inflammatory membrane with more or less degree of fibrosis. Organization depends upon the duration of the lesion. The lesions are covered over at least part of their circumference by parietal or visceral peritoneum. This characteristic together with the history, which usually precedes the appearance of such lesions, suggests that the lesion takes its origin from a localized collection of fluid in a closed peritoneal or retroperitoneal space with the formation of an inflammatory membrane. The fact that the content of the cyst contains significant levels of pancreatic amylase suggests that the communication with the pancreatic duct and the continued inoculation of the pseudocyst with pancreatic secretion are associated with, if not responsible for, the maintenance of the cystic space. For these reasons it seemed logical to approach the production of pseudocysts, first and primarily, by means of experimental production of a fistula from the pancreatic duct to the peritoneal cavity, the canine pancreas

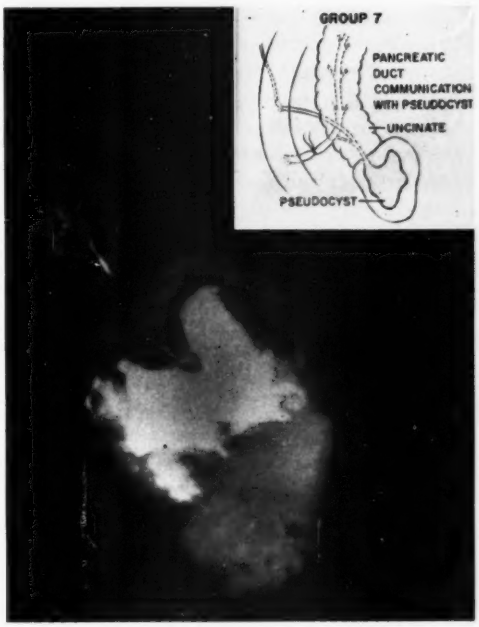

FIG. 6. Radiogram of pseudocyst in group 7 animal after injection with contrast medium. Communication of cyst cavity with ductal system.

being an intraperitoneal organ. In groups 1 and 2, when fistulas were created in such a fashion that pancreatic secretion was permitted to pour freely into the peritoneal cavity, cyst formation did not occur. It would seem, then, that one condition necessary for pseudocyst production is secretion into a closed space rather than into the peritoneal cavity. In group 3 a closed compartment was established and pseudocysts were produced. Secondly, it would appear that the presence of an actively secreting gland, secreting at a relatively normal or higher pressure into the closed peritoneal space, is essential for the production or at least for the maintenance of pancreatic pseudocysts. Thus, in group 4, in which complete ductal occlusion led to pancreatic atrophy which was found at autopsy, pseudocysts were conspicuous by their absence. Therefore, in addition to the requisites of a ductal fistula into an enclosed peritoneal space, there must be added the necessity for a pancreas of active secretory ability. Thirdly, it would appear from groups 3, 6, and 7 that there is necessity for interference with normal pancreatic ductal drainage. Thus, when free drainage in the normal direction through an unobstructed pancreatic ductal system is permitted as in group 5, the fistula, regardless of the means of creation, the size of the fistula, or the space into which it drains, tends to close spontaneously and pseudocysts either fail to appear or are reabsorbed.

In group 7 the following conditions were met. There were present: (a) a closed peritoneal space, (b) an actively secreting pancreas, (c) a ductal fistula, and (d) partial obstruction to normal ductal out flow. In this group the largest cysts were found and the lesion was most consistently produced. In 4 animals in which cysts were not produced, open accessory pancreatic ducts were found at autopsy examination which permitted adequate drainage in the normal direction.

The experiments involving the determination of transaminase are difficult to interpret. It would seem that the most logical deduction to be made is that transaminase elevation results from the inflammatory reaction which forms the pseudocyst wall and perhaps from tissue necrosis. It would be of interest to compare transaminase contents of true cysts and pseudocysts of the human pancreas.

The application of the experimental data to clinical material would appear to suggest the following: that a rational approach to the treatment of pancreatic pseudocysts should be based on pancreatography. Cysts arising from the proximal end of the disrupted pancreatic duct may be treated by restoration of normal ductal drainage, e.g., lithotomy or sphincterotomy, or both. Pseudocysts arising from the distal end of the disrupted duct should logically be amenable to distal pancreatic resection or retrograde pancreatic drainage.

The role which is played by external or internal drainage cannot be assayed from these experiments, but it is conceivable and, even likely, that a well developed pseudocyst may lose its original communication with the ductal system and, therefore, require some other route of decompression or drainage.

SUMMARY

A series of experiments leading to the production of pseudocysts of the pancreas in dogs is reported. Analysis indicates that the following factors are involved in the pathogenesis of the lesion: (1) ductal communication with the cystic cavity; (2) a closed space; (3) a secreting pancreas; (4) interference with normal pancreatic ductal drainage.

The role of these factors in pathogenesis is discussed, and their possible clinical significance in treatment of pseudocysts is evaluated.

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THE IMPORTANCE OF EARLY EXPLORATION OF VASCULAR INJURIES

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THE APPROACH to the treatment of injuries to large blood vessels has changed markedly within the last 10 years. It has changed because experiences in the recent wars have shown that immediate and definitive treatment of major arterial injuries resulted in a larger percentage of functioning extremities. As a result of the development of techniques of repair and the availability of vessel graft banks, immediate restoration of vessel continuity is not only now possible but highly desirable.

Although the opportunities for vascular surgery are greatest during wars, large city hospitals are faced with the problem of treating acute vascular injuries that, fortunately, are not complicated by associated extensive soft tissue damage. The occurrence of small knife wounds and the low velocity of the missiles involved in most civilian gunshot wounds, combined with the rapidity with which these patients are brought to the hospital, constitute a combination of circumstances most favorable to successful handling of these problems.

Homer G. Phillips Hospital is a 750 bed city hospital from which all of the material reported upon in this article was obtained. The cases were selected from over a 10 year period, and the series includes only those cases in which surgical exploration was carried out because of suspected vascular injury. No case is included in which visceral or intracranial vessels were involved. No case is included which involved stab wounds or gunshot wounds of the abdomen because any intra-abdominal vascular injury would have been revealed during the mandatory explorations that are carried out in this hospital for these injuries.

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Injuries to great vessels supplying the limbs and, occasionally, to the great vessels in the neck, in the past, have been treated in the conservative or nonoperative manner. Prior to 1948, that approach prevailed at this institution. Between the years 1948 and 1954, there was a gradual but cautious change to an aggressive attack on vessel injuries. Unless associated injuries required it, patients sustaining penetrating injuries over the course of great vessels that lay external to the abdominal cavity were rarely systematically explored. Active bleeding was controlled by pressure dressings, and if bleeding vessels were present in the wound, they were ligated. Clean wounds were closed primarily, and any injury to deep lying major vessels went unrevealed. Frequently in these patients massive hematomas developed which required evacuation and which more frequently caused pain. Those hematomas that did not require evacuation often organized and scarred in the vicinity of major neurovascular bundles. Other patients similarly treated returned with painful and often disabling false aneurysms and arteriovenous fistulas.

In the present article the importance of exploration of all penetrating wounds which occur in the vicinity of large vessels is emphasized and evidence to support this point of view is presented.

The experience with great vessel injuries in the last 10 years at this hospital is also presented. Over the 10 year period 83 explorations were carried out. The ages of the patients ranged from 21 months to 76 years. There were 72 males and 11 females.

The time interval from injury to admission varied from 10 minutes to 5 days, with the average being 1.1 hours. The time interval from admission to exploration varied from 20 minutes to 13 hours with an average of 4.2 hours. Twenty-six patients were admitted in shock and the interval from admission to surgery in these patients averaged 2.6 hours. Several patients presented themselves for emergency treatment but refused definitive operation for several hours until persistent hemorrhage or the pain of severe distal arterial insufficiency alarmed them sufficiently to accept it.

The associated injuries in many of these cases usually were confined to adjacent nerves and tendons, and on 2 occasions involved missile fractures of the femur. One case involved a crushing injury of the lower thigh and leg with compound comminuted fractures of the tibia and fibula. Frequently, associated veins were involved in arterial injuries. Associated injuries, however, were of little significance in treating most of the cases in this series except in those instances in which severe nerve damage prevented complete restoration of function.

The cases are grouped in 3 categories. Those cases in which the major vessels injured were arteries are grouped as arterial injuries. Although frequently the accompanying veins were also injured, the arterial injury was considered the most significant. Grouped under venous injuries are those cases in which at exploration the major injury was to a large vein. In the third group of cases are those in which exploration revealed no injury to either major arteries or veins.

ARTERIAL INJURIES

Of the 83 cases, 42 were of arterial injuries. In many cases of major arterial injury the accompanying veins were also involved. The ages of these patients ranged from 10 to 76 years with the highest incidence occurring in the age group between 20 to 40. This observation would be expected when one considers the fact that these wounds were almost without exception inflicted with the violent intent characteristic of young males, who were involved 6 times more frequently than females.

TABLE I.—TYPES OF INJURY TO 42 ARTERIES

Artery	*Laceration*	*Transection*	*Perforation*	*Compression spasm contusion*	*Total*
External carotid	0	0	1	0	1
Internal carotid	0	0	1	0	1
Subclavian	0	1	0	0	1
Axillary	0	2	0	0	2
Brachial	3	3	2	1	9
Radial	0	2	0	0	2
Ulnar	0	3	0	0	3
Common femoral	0	1	0	0	1
Superficial femoral	6	4	5	0	15
Popliteal	2	2	0	1	5
Lat. fem. circumflex.	0	1	0	0	1
Vertebral	0	1	0	0	1
Total	11	20	9	2	42

The arteries most frequently injured were the brachial, the femoral, and the popliteal. The most frequent type of injury to the arteries was transection followed by laceration and perforation (Table I). The term transection in this series was applied to any vessel with interruption of more than 50 per cent of its circumference. In 2 vessels there was no interruption of continuity, but when examined at exploration they were either compressed or in "spasm" as a result of missiles passing near them.

Twelve vessels were ligated. Seven of these were arteries not considered to be essential to the welfare of the tissues distal to them. Five were arteries of major importance. Twenty-seven arteries were repaired either by simple suture, or resection of the damaged segment and reanastomosis, or insertion of a homograft or autograft. No prostheses were used in this group of cases (Table II).

Two patients required only decompression and local application of vasolytic agents. In 2 patients exploration with no definitive treatment was carried out because one expired on the table and the other had innumerable minute perforations of a long

TABLE II.—METHODS OF TREATING 42 ARTERIAL WOUNDS WITH RESULTS AND COMPLICATIONS

	Ligation	*Primary suture*	*Resection and anastomosis*	*Resection and homograft*	*Resection and autograft*	*Other*	*Totals*
External carotid	1*	0	0	0	0	0	1
Internal carotid	1***	0	0	0	0	0	1
Subclavian	0	0	0	1	0	0	1
Axillary	0	1*	1***	0	0	0	2
Brachial	0	2	5* *	1	0	1	9
Common femoral	1****	0	0	0	0	0	1
Superficial femoral	1	4***	8	0	1	1	15
Popliteal	1**	1* **	2	0	0	1	5
Radial	2	0	0	0	0	0	2
Ulnar	3	0	0	0	0	0	3
Lateral fem. circum.	1	0	0	0	0	0	1
Vertebral	1	0	0	0	0	0	1
Totals	12	8	16	2	1	3	42
RESULTS AND COMPLICATIONS							
Viable extremity with pulsations in the injured artery	0	5	13	2	1	3	24
Thrombosis*	2	2	2	0	0	0	6
Gangrene**	1	1	0	0	0	0	2
Atrophic painful extremity****	1	0	0	0	0	0	1
Death***	1	1	1	0	0	0	3

segment of the superficial femoral artery due to a shotgun wound.

Ligation. Two men, 45 and 27 years of age, sustained gunshot wounds of the neck which resulted in perforation of the internal carotid artery in one and of the external carotid in the other. In both instances ligation of the respective damaged artery was performed under general anesthesia. The patient with the ligated internal carotid artery died 5 days later with severe brain dysfunction. In the other patient hemiplegia developed following what clinically appeared to be thrombosis of the internal carotid artery. Both patients were in shock during the operative procedures.

Ligation of the common femoral artery in a 23 year old female who sustained a stab wound of the thigh with transection of the artery resulted in a painful cold and atrophic lower extremity with ankylosed interphalangeal and ankle joints.

Ligation of the superficial femoral artery in its middle one-third in a 34 year old male, who sustained a gunshot wound of the thigh with transection, resulted in a return to complete function with palpable pedal pulsations.

Ligation of the popliteal artery in a 45 year old man who had sustained a gunshot wound of the lower leg with compound comminuted fractures of the tibia and fibula resulted in gangrene and subsequent amputation 4 days later.

Decompression and application of vasolytic agent. One patient, a 23 year old female, sustained a gunshot wound of the brachium. There was no indication for exploration other than a wound of entry in the vicinity of the brachial artery below the profunda. However, at exploration severe spasm of the brachial artery was present and was relieved by procaine injection into the arterial wall. She had an uneventful recovery.

One other patient was also treated by decompression of the popliteal artery following a gunshot wound through the calf, which resulted in mild, distal arterial insufficiency. After decompression, the weak distal pulsations remained weak, but at discharge 14 days later, pulsations were strong in the posterior tibial and dorsalis pedis arteries, and the limb was functional. The patient refused follow-up arteriography which we had hoped would demonstrate whether or not thrombosis had occurred at the site of "spasm."

Repair. Eight cases of injured brachial arteries were repaired. In 5 cases, resection with primary anastomosis was performed.

Three of these 5 resulted in functioning limbs with pulsations at discharge from the hospital. Poorly functioning arms and hands occurred in 2 cases because of extensive thrombosis in the brachial arteries. In 1 of these, subsequently the thrombosed segment was resected and a venous autograft substituted. The other patient's arterial difficulty was complicated by injury to the brachial plexus and severe causalgia. She has refused further surgery. In 2 patients simple suture repair was performed and in 1 a 6 inch homograft was inserted following resection of an extensively injured brachial artery. They were discharged with strong distal pulsations and without apparent vascular impairment.

In 13 patients primary repair of injured superficial femoral arteries was performed. In 4 simple suture repair was carried out, in 8 resection with primary anastomosis, and in 1 resection and a saphenous vein autograft. All, except 1 patient had immediate postoperative pulsations and were discharged with apparently normal functioning limbs. One died 5 days postoperatively with severe delirium tremens.

Three patients underwent repair of the popliteal artery. In 2, resection with primary anastomosis resulted in return of pulsations immediately postoperatively and functional limbs at discharge. The third patient had a simple suture repair. Subsequently thrombosis of the popliteal artery and gangrene developed, and an above the knee amputation followed. It is thought that failure to resect the area of damage was a contributing factor in the development of the thrombosis. In the 2 successful cases the damaged segments were resected, and the anastomosis was then performed with undamaged intima approximated to undamaged intima.

In 1 patient the subclavian artery was resected and a homograft inserted following a gunshot wound of the subclavian artery. Distal pulsations appeared immediately postoperatively and have remained present; however, injury to the brachial plexus coincident with the gunshot wound has prevented full return of function.

In 2 patients the axillary arteries were repaired. One who underwent resection and anastomosis with excellent postoperative pulsations expired 8 hours postoperatively. At autopsy no apparent cause of death could be determined. The second patient underwent primary anastomosis without resection following a stab wound which transected the axillary artery. The distal pulses were weak postoperatively and thrombosis of the axillary artery developed with moderate distal arterial insufficiency. He has since undergone a dorsal sympathectomy which has not helped him. He has refused further surgery. It is believed that in this case, as in the cases mentioned before, thrombosis could have been avoided, had resection of the damaged area been carried out.

Of 27 injured arteries which were repaired, viable extremities with pulsations were obtained in 21 (72.7 per cent) at discharge. If the 2 deaths which occurred not as a result of any treatment to the arteries are excluded, this percentage rises to 84 per cent.

VENOUS INJURIES

In missile injuries and stab wounds penetrating areas crossed by great vessels, occasionally the artery in the vicinity is spared injury, and only the accompanying vein is damaged. In many instances, it is impossible to make a positive distinction short of exploration.

Sixteen cases involved injury to a major vein or one of its larger branches. The most frequent anatomic site involved was the neck, followed by the thigh. The vessel most frequently injured was the internal jugular vein followed by the superficial femoral. Of these 16 venous injuries, 9 were lacerations, 5 were transections, and 2 were perforations (Table III). Ligation was carried out in 12 cases and suture repair performed in 3. The veins that were sutured were a superficial femoral vein, a subclavian vein, and an innominate vein.

TABLE III.—VENOUS INJURIES, THEIR TREATMENT AND RESULTS

Vein	*Transection*	*Perforation*	*Laceration*	*Ligation*	*Repair*
Internal jugular	2	1	3	6	0
External jugular	1	0	1	2	0
Axillary	1	0	0	1**	0
Subclavian	0	0	1	0	1
Innominate	0	0	1	0	1
External iliac	0	1***	0	0	0
Superficial femoral	1	0	3	3* **	1
Results:					
*Edema				1	0
**Wound infection				2	0
***Death				1	0
Uneventful recovery				9	3

In 2 patients wound infections developed. In 1 transient edema of the lower extremity developed following ligation of the superficial femoral vein. No major complications were attributable to the actual ligation of the injured veins. One death resulted from massive hemorrhage from the external iliac vein before the injured vessel could be exposed and controlled. It is believed that ligation of major veins serve no good purpose. It has been the policy since 1956 to repair all major veins.

NEGATIVE EXPLORATIONS

If criteria used in deciding upon exploratory procedures are designed to reveal every possible major vessel injury, it is inevitable that a certain number of explorations will reveal no injury to either a major artery or vein. In this series 25 exploratory operations were performed in which no injured major arterial or venous channels were found. Eight of these were explorations of the thigh, 9 of the neck, and 4 of the axilla. The shoulder area, the brachium, the popliteal space, and the anterior tibial compartment were explored once each. No complications and no deaths resulted in this group.

DISCUSSION

From October 1948 to October 1954, only 17 explorations were carried out for suspected arterial or major venous injuries. In 11 of the 17 cases exploration revealed significant injuries to arteries or large vessels. There were 15 cases of arteriovenous fistulas and traumatic aneurysms seen during this period. Emergency treatment was performed at this hospital for the initial injury in 12 cases and surgical exploration in 1. Of the remaining 2, no initial care was given in one and conservative treatment at another hospital in the other case.

However, since 1954, 66 explorations have been carried out with significant injury to vessels found in 47 cases. Since 1954, there have been only 2 patients with arteriovenous fistulas and 1 with traumatic aneurysm admitted to the surgical service all of which resulted from lack of initiative on the part of the patient in seeking immediate attention. One presented himself 6 days after injury with a false aneurysm of the left anterior tibial artery. Another presented himself 7 years after having been treated conservatively for a stab wound of the thigh. The third patient presented himself 25 hours after having sustained a gunshot wound of the elbow which resulted in an arteriovenous fistula and a false aneurysm of the brachial artery. Since 1954, we have not observed an arteriovenous fistula or a false aneurysm resulting from injuries to vessels in individuals who presented themselves for early initial care. We believe that this is due to an insistence on exploration in all patients with evidence suggestive of major vessel injury. The eradication of arteriovenous fistula and false aneurysms resulting from trauma is an obtainable end. As Table IV indicates, these serious complications can be markedly reduced or prevented by early exploration for potential vascular injuries.

When indications are clear, there must be no hesitation in exploring systematically the areas involved. When indications are doubtful, every effort should be made to establish the presence or absence of vessel injury.

INDICATIONS

Selecting cases for exploration has not proved to be a difficult task. In any patient with a penetrating wound and one or more

of the following criteria exploration was performed: (1) pulsatile bleeding, (2) active bleeding, (3) distal arterial insufficiency, (4) a pulsating or increasingly large hematoma, or (5) a penetrating wound over the course of any large vascular bundle. The locations considered demanding exploration at this hospital are the following: the neck, axilla, brachium, antecubital space, femoroinguinal area, and popliteal area.

Of the 42 arterial injuries, the major indication for exploration in 20 (47.6 per cent) was distal arterial insufficiency. Active bleeding was the major indication in 10 cases (23.8 per cent). Pulsatile bleeding was the major indication in 2 cases. In 5 cases, location of the wound was used as the indication due to the absence of the other 4. Of the 16 major venous injuries, active bleeding was the indication in 14 cases (87.5 per cent) and location of the wound was the indication in 2 cases.

Of the 25 explorations in which no major artery or vein was injured, 12 were performed because of hematoma formation or active hemorrhage; 13 because of the location of the wound. The effective control of bleeding vessels that systematic exploration permitted in 12 cases prevented or decreased the formation of hematomas. Exploration also resolved all doubt concerning the presence of injury to great vessels and in 2 cases permitted the control of the bleeding of minor vessels which was sufficient to have caused shock.

Since 1955, it has been the policy to obtain arteriograms in those cases in which the indications are doubtful. If major arterial integrity is demonstrated by the injection of one of the radiopaque iodide preparations into the artery proximal to the site of possible injury, it is justifiable to continue to observe that patient. This approach is particularly appropriate in small firearm missile injuries in which external hemorrhage is minimal but in which definite injury to a major vessel could exist. A negative arteriogram does not rule out injury to a large vein, however.

TABLE IV.—DECREASING INCIDENCE OF ARTERIOVENOUS FISTULAS AND TRAUMATIC ANEURYSMS AS EXPLORATIONS INCREASE

	1948–1953 *No. of cases*	*1954–1957* *No. of cases*
Explorations	17	66
Major vessels involved	11	47
No major vessels involved	6	19
Arteriovenous fistulas and false aneurysms surgically corrected	15	3
Arteriovenous fistulas and false aneurysms initially treated at this hospital	13	0

SHOCK

Shock or a systolic blood pressure below 90 millimeters of mercury is a significant observation. Of the 27 patients in the entire series who were admitted in shock or with a systolic blood pressure below 90 millimeters of mercury, 2 had bled from cut wound edges and had had no major arterial or venous injury. The remaining 25 did sustain a major arterial or venous injury. Twenty of the 42 arterial injuries (46.6 per cent) and 5 of the 16 venous injuries (31.3 per cent) comprise this group. This finding was used many times as the basis for speeding the patient to the operating room; e.g., the average time interval from admission to surgery for the 83 patients was 4.2 hours, but for those admitted in shock the average time interval was 2.8 hours. The fact that the average time interval from injury to admission was 1.1 hours, coupled with the dispatch with which those patients admitted in shock were treated definitively has been important in keeping the mortality and morbidity low.

The treatment of these patients begins in our emergency room where, if required, antishock therapy is begun. They are typed and cross-matched and whole blood is obtained and administered as indicated. Careful attention is given to all associated injuries. If major vessel injury is suspected, exploration is carried out as soon as is consistent with satisfactory preoperative preparation. Every effort within the time limit permitted by the circumstances is made to restore the patient to as near normal as possible.

All of the patients receive antibiotics,

tetanus antitoxin, or toxoid and polyvalent antiserum as a precaution against tetanus and gas gangrene. Liberal use of antibiotics is continued postoperatively.

Such an approach to the treatment of great vessel injury has resulted in a decrease in the number of arteriovenous fistulas, false aneurysms, and poorly functioning limbs. Morbidity has been lessened and in some cases death has been prevented by aggressive surgical intervention.

SUMMARY

It is recommended that all penetrating wounds in the vicinity of great vessels be immediately explored or arteriograms be performed to exclude arterial injury. It must be remembered, however, that negative arteriograms do not exclude the presence of major venous injury.

Ligation of major vessels is undesirable and, when performed, may result in serious complications with subsequent major or minor disability.

The immediate restoration of injured arteries, by resection of damaged areas and primary repair with simple suture or the use of autografts or homografts, is stressed to achieve the best results.

Infections should be avoided if at all possible by aseptic technique and the use of antibiotic therapy.

EDITORIAL

RESEARCH IN SURGERY

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SURGICAL RESEARCH has extended progressively into the basic sciences during the last 40 years. Research in anatomy proved to be an obvious first interest to surgeons, and since the turn of the century some schools, notably in Edinburgh, have built much of their reputation on their studies in surgical anatomy.

Later, there was a cautious invasion of physiology which has progressed to the degree that experimental surgeons currently occupy a large part of the field and, not content with this, they are making serious inroads into the field of biochemistry. There was a trend in bacteriology for a few years when surgeons began to play a major role, but the antibiotics became so numerous and diverse that the subject became too complex for anyone but a full time bacteriologist to understand.

Of course, none in the basic sciences believes the field "invaded" because nearly all the physiologists are doing biochemistry, and the biochemists are looking more like physicists because of their preoccupation with by-products of dismembered atoms. The physicists are so busy dealing with smaller and more intimate details of the structure of the atom, with peculiar mathematical formulas, and with incredible sources of energy, that they scarcely notice this trend.

So we have, in a matter of a quarter of a century, surgery in its broadest physiologic and biologic sense looking very much like a true science. Since it deals with the active treatment of disease, the results of surgical research are often very obvious and gratifying. Such results provide a stimulus not only to the surgical investigator but to his medical colleagues. This point is illustrated by a stimulation to study the natural life history of heart disease and rheumatic fever provided by technical advances in heart surgery, the study of liver disease prompted by the portacaval shunt operation, and many more examples in every section or field of surgery.

Does experimental surgical research command undue recognition and kudos both from the profession and the laity? Twenty or more years ago this was the case, and there followed a period when the surgical literature was flooded with a variety of research reports of varying value. Present day standards of work are higher, journals are more critical, and surgeons, many of whom have had first hand experience in research laboratories, prove to be very discriminating readers. Men working in the exact sciences look askance at the nebulous variables with which a biologic researcher must contend. In private, and sometimes even in public, he will wonder if biologic research is even justified under such conditions. One's first reaction to such an attitude may be a sense of inferiority. However, on contemplating the difficulties in biologic research, one may be justified in feeling as good, if not superior, when conclusive experimental results are

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obtained in the face of such adverse conditions.

What of the fellow who had an idea and no "money or facilities" to develop it? This situation is unfortunate, but the longer one is in research the less unfortunate it appears. If there really is a flame in this individual, which is strong enough to see a project through to its final documentation and completion, then in most cases he will not stop at these initial hurdles. Nothing attracts financial support more than the evidence that you have enough drive to initiate a project. Sometimes a little adversity may be a stimulus, especially if the researcher is a sensitive individual.

One conversely should not confuse "facilities and money" with "original ideas." A well appointed, wealthy laboratory does not necessarily bring original ideas but such laboratories are essential for the development of the idea. Most fundamental concepts in science were born without elaborate apparatus and one must distinguish between such concepts and "developmental research." It has been suggested that modern, highly organized, interdepartmental teams, although very necessary, are a deterrent to the clear and uncluttered thinking which produces the basic ideas or concepts.

Curiosity, thoughtfulness, and honesty are well known personal characteristics that go toward successful research. Perhaps the part that tenacity plays is referred to less frequently. Tenacity is a valuable characteristic in research. It can be too strong a part of the character and lead to long, tedious, unrewarding hours of work. Doctor Charles Best once said that it was often important to know when to leave a particular line of research. I believe, however, that research suffers more often from lack of tenacity than from too much. There is a tendency in modern research laboratories to be "on the bandwagon" and to be riding whatever field of research is currently active and popular. There are also brilliant minds that lose interest once they have discovered a new approach to the problem. They are not stimulated to develop it to the point where its true clinical value is assessed.

Perhaps there are two other characteristics. Enthusiasm is rather an obvious trait but, on close examination, the researcher is often found to be an individual who is basically optimistic in his entire outlook on life.

What are the future trends going to be in surgical research? As stated before, we have progressed through anatomy, physiology, and into biochemistry. The next important basic science discipline which will play a role in our future research is physical chemistry. It is likely that we will be talking about electrical activity of a substance rather than its chemical formula in future years. Why does protamine attack heparin so violently and exclusively in vivo? They are two of the most highly charged substances used clinically.

It will be some years before medical science can effectively control premature degeneration of the vascular tree, rheumatic fever, and the periodic appearance of congenital cardiac defects. Trauma will presumably always be with us as long as we move about. For these reasons, cardiovascular surgery offers as fertile a field as any for surgical research. It would appear that the next great surgical era will involve transplantation of homologous, or even heterologous, tissues and organs. To effect such procedures, we are looking at present to the cardiac bypass techniques. It is entirely likely, however, that within the foreseeable future the heart-lung pump may be obsolete. The maintenance of tissue oxygenation, which is the prime purpose of the pump, will probably be replaced by the use of chemicals which temporarily put the tissues at rest and suspend their complicated metabolic processes. This condition may be achieved by pure chemical means or it may be brought about by the use of very low body temperatures.

What of our surgical research fellows? It becomes more important as time goes on to

see that they become a part of one of the basic science disciplines during their year or two of training. They must absorb very exacting, scientific method and planning which is not always offered to a man who spends his time on a practical physiologic problem dealing with dog surgery. The latter training is of more immediate practical value, but more fundamental disciplines should be included in the training of a man who shows promise of some day in the future conducting a university research project of his own. He will of necessity work on a team with men from the basic sciences. He must understand their approach to a problem as well as possess a certain background of knowledge in order to insure adequate communication.

THE SURGEON AT WORK

LEIOMYOSARCOMA OF THE ESOPHAGUS

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PRIMARY SARCOMA of the esophagus was first reported by Chapman in 1877. In the next 25 years, 9 additional cases were reported, which were represented as fibrosarcomas and lymphosarcomas. In 1902, Howard reported the first case of smooth muscle cell variety similar to the type being presented. Sarcomas of the esophagus have been shown to comprise only about 0.5 per cent of all malignant esophageal neoplasms. Among these mesenchymal tumors, fibrosarcomas occur most commonly, while leiomyosarcomas are extremely rare, particularly in the upper third of the esophagus where the musculature is of the striated variety.

The mucous membrane of the esophagus has a much greater incidence of neoplastic change than the muscular layers, as is also the case in other portions of the intestinal tract. Carcinoma of the esophagus constitutes 50 per cent of all malignant neoplasms. At the Mayo Clinic, from 1920 to 1949, the diagnosis of leiomyoma and leiomyosarcoma of the esophagus was made on 18 occasions; whereas, the diagnosis of carcinoma was made in 2,312 cases (7).

Twenty cases of leiomyosarcoma of the esophagus have been reported, which are summarized in Table I. One from Emory University Hospital is being added to those previously reported.

CASE REPORT

Mrs. M. L. H., aged 75 years, was admitted with a 2 year history of progressive dysphagia and respiratory obstruction of 4 months' duration. The patient had noted a mass in the neck for 1 year, but no hoarseness nor cough was present. Breathing was easier in the standing than in the recumbent position. At the time of admission, she could tolerate only liquids; she had lost 70 pounds in weight in a 14 month period.

Physical examination revealed a well developed, obese, elderly female with an audible inspiratory wheeze. A mass was found in the left side of the neck, measuring 5 centimeters in diameter, which was firm and extended to the midline. The trachea was slightly displaced to the right. No lymph nodes were palpable in the neck.

Results of laboratory studies revealed: a hemoglobin of 14.2 grams, sedimentation rate 74, leucocyte count 11,400, protein bound iodine 5.1 micrograms per cent, and blood cholesterol 280 milligrams.

Fluoroscopic examination of the chest on the day of admission revealed marked widening of the superior mediastinum to the right and left (Figs. 1 and 2). The esophagus was markedly dilated from the level of the fifth cervical vertebra to the bifurcation of the trachea. Within the dilated esophagus were multiple lobulated filling defects. Esophagoscopy was carried out, and no obstruction of the lumen of the esophagus was found. A superficial biopsy was done, and the microscopic examination of the tissue removed from the esophagus revealed leucoplakia (Fig. 3).

The patient was operated upon on September 7, 1956, under general anesthesia. The lesion was approached through a low anterior transverse incision. The sternothyroid and sternohyoid muscles were divided and the esophagus mobilized. The esophagus contained a large, freely movable mass. An incision was made on the left lateral aspect, and the tumor was delivered. It arose from the right lateral wall of the upper cervical portion. The lesion extended for approximately 15 centimeters and was unattached except at a 2 centimeter base. It was pale in color and had a semitranslucent, irregular surface. The lesion was excised, and a wide margin of normal esophagus was removed; the defect was closed easily because of the laxity of the tissues. A tracheotomy tube was inserted to prevent difficulty in breathing and to allow for easy postoperative care.

The specimen consisted of an elongated, rounded tumor which weighed 9.1 grams and measured 14.8 by 5.5 by 3.0 centimeters. It was smooth and had a

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FIG. 1.

FIG. 2.

FIG. 1. Lateral roentgenogram of chest showing deformity of esophagus upon barium swallow.
FIG. 2. Roentgenogram demonstrating free flow of barium through the esophagus but denoting the displacement and reduplication.

lobulated external surface. No induration or ulceration was noted; and cut section revealed soft, mucoid tissue. Microscopic examination showed a diffuse neoplastic infiltration, involving predominantly the muscle coat. The cells were arranged in ill defined cords and consisted of round or occasionally spindle-shaped elements, the nuclei of which varied from spherical to rod-shaped. The cytoplasm of the round cells was eosinophilic; whereas, the elongated cells were acidophilic. Special connective tissue stains revealed a distinct myoblastic character of the cells. There was a fair degree of nuclear pleomorphism and increased mitotic activity. No evidence of true encapsulation was denoted. These elements were considered characteristic of a leiomyosarcoma (Figs. 4, 5, and 6).

The postoperative course was uninterrupted. The Levin tube was removed on the seventh postoperative day, and the tracheotomy tube was removed on the tenth postoperative day. The patient had no difficulty in eating and was discharged on the sixteenth day.

On follow-up examination, 19 months later, the patient was experiencing no dysphagia, dyspnea, pain, or hematemesis. Her strength was much improved, and she had gained 35 pounds. No abnormality was noted by barium swallow; however, roentgenograms of the chest revealed a soft, rounded lesion in the right lung which was suggestive of metastatic disease (Fig. 7).

DISCUSSION

Smooth muscle tumors of the esophagus present a special problem in diagnosis because of

FIG. 3.

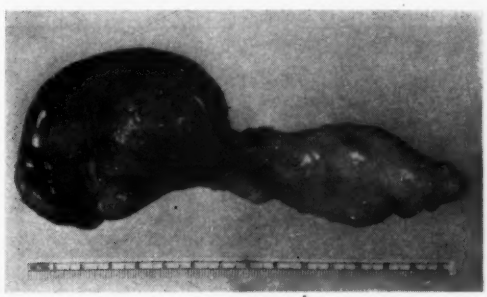

FIG. 4.

FIG. 3. Photomicrograph of biopsy specimen obtained at esophagoscopy, failing to reveal the true characteristics of the tumor by such an examination.
FIG. 4. Photograph of the removed specimen demonstrating the free portion which extended down the esophagus to the level of the bifurcation of the trachea.

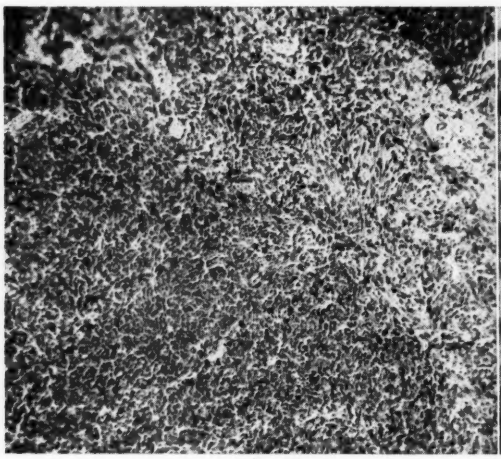

FIG. 5.

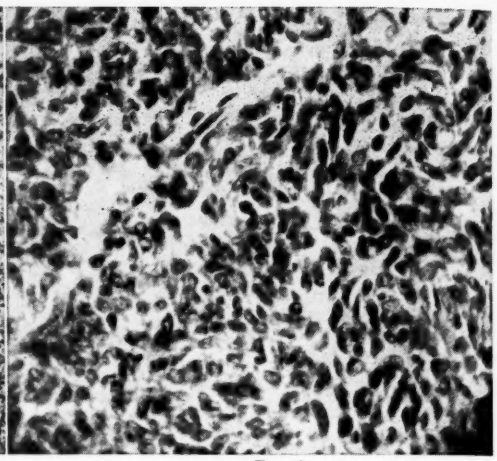

FIG. 6.

FIG. 5. Low power magnification of cross-section of the tumor demonstrating the true mesoblastic type present.

FIG. 6. High power magnification of tumor removed showing the spindle-shaped characteristic cell with numerous mitoses.

the anatomic characteristics and location of the organ. The physical examination is not very helpful in diagnosing these lesions. All patients who complain of continued dysphagia should receive a barium swallow, followed by esophagoscopy, to avoid missing this and similar conditions.

Radiographically, leiomyosarcoma cannot be differentiated from other malignant tumors of the esophagus. Since local infiltration into the mediastinum occurs, it may produce a shadow resembling primary mediastinal tumor. The diagnosis of the ulcerative group is not difficult, inasmuch as a barium swallow shows a narrowing or an irregularity of the lumen. The large pedunculated tumors are misleading, since they appear as a smooth stricture with a dilated esophagus above, containing food mixed with barium.

FIG. 7. Postoperative roentgenogram revealing coin-shaped lesion in the right middle lobe which apparently represents a metastatic lesion.

The appearance at esophagoscopy usually resembles carcinoma; however, a pedunculated tumor may be missed, as it was in the case reported. If the mucosa is intact, a biopsy is difficult to obtain because of the nature of the stricture and the fear of perforation or hemorrhage. If the lesion is ulcerated, a biopsy may be difficult to interpret because of the presence of secondary inflammation and the inability to obtain the characteristic tissue.

The diagnosis of smooth muscle tumor can only be confirmed at operation; and even then, it is impossible to distinguish a leiomyoma from a leiomyosarcoma. A soft tumor is more likely to be malignant than a firm one, although a benign tumor may be soft should necrosis occur secondary to diminished blood supply.

There is an increased morbidity and mortality associated with esophageal resection and, especially, at the esophagogastric junction. If a benign leiomyoma is found, it can be removed without extensive resection. For this reason, biopsy at operation may be justified since

TABLE I.—RÉSUMÉ OF ALL REPORTED CASES OF LEIOMYOSARCOMAS

Author	*Year reported*	*Sex*	*Age*	*Location*	*Type*	*Metastases*	*Symptoms*	*Duration*	*Treatment and remarks*	*Survival*
Howard	1902	M	51	Distal ⅓	Infiltrating	Stomach regional nodes	Dysphagia vomiting	Several weeks	None, died of exhaustion	3 wks.
Von Hacker	1908	—	—	Distal ⅓	Polypoid	None	—	—	—	—
Mallory	1935	M	61	Distal ⅓	Infiltrating	Regional nodes	Regurgitation, weight loss, weakness	10 yrs.	Inoperable, x-ray therapy	2 wks.
Menne	1937	M	38	Upper ⅓	Infiltrating	Lung	Dysphagia, pain swallowing	7 yrs.	Esophagoscopy, radium implant, and x-ray	12 wks.
French	1941	M	70	Distal ⅓	Polypoid	None	Dysphagia, anorexia	2 mos.	Esophagoscopy, none	4 mos.
Pennes	1942	M	53	Middle ⅓	Infiltrating	Mediastinum	Sensation of pressure, wt. loss, weakness	6 mos.	Biopsy diag., gastrostomy, and deep x-ray	2 mos.
Harrington	1949	F	60	Distal ⅓	Polypoid	None	Dysphagia, substernal pain	1 yr.	Biopsy. Probably sarcoma	4 wks.+
Harrington	1949	F	70	Distal ⅓	Polypoid	Wall of pulmonary vessels	Dysphagia	3 wks.	Biopsy diag., inoperable infiltration	6 wks.+
Case A361 Univ. of Texas	1949	F	56	Distal ⅓	Polypoid	None	Dysphagia	8 mos.	Esophagogastrostomy, leiomyosarcoma	1 yr.
Lyons	1951	F	58	Distal ⅓	Polypoid	None	Dysphagia, pain, weight loss	1 yr.	Biopsy diag., esophagogastrostomy	4 yrs.+
Owens	1951	F	56	Distal ⅓	Polypoid	None	Dysphagia, weight loss	8 mos.	Esophagogastrostomy, leiomyosarcoma	25 mos.+
Blanco	1952	F	65	Middle ⅓	Polypoid	Mediastinum	—	1 yr.	—	—
Neil	1953	M	54	Upper ⅓	Polypoid	None	Hoarseness, dysphagia	1 mo.	No esophagoscopy due to hemorrhage	3 wks.
Johnston	1953	M	64	Distal ⅓	Infiltrating	None	Dysphagia, weight loss, hoarseness	2 yrs.	Perforated esoph. at esophagoscopy, septicemia	1 wk.
Johnston	1953	F	60	Distal ⅔	Infiltrating	None	Dysphagia, substernal pain	1 yr.	Biopsy, fibrosarcoma. Esophagogastrostomy	7 yrs.+
Johnston	1953	F	60	Upper ⅓	Infiltrating	—	Dysphagia	—	Biopsy, sarcoma inoperable	—
Johnston	1953	F	60	—	Infiltrating	—	Dysphagia	—	Biopsy, sarcoma	—
Lipschultz	1954	M	32	Upper ⅓	Infiltrating	Perforated to rt. apex	Chest pain	2 wks.	Treated for pneumonia. Expired from perforation	2 wks.
Creech	1955	M	62	Middle ⅓	Polypoid	None	Dysphagia, epigastric pain	3 mos.	Biopsy diagnosis esophagogastrostomy	3 mos.
Martin	1957	F	75	Upper ⅓	Polypoid	Lung	Dysphagia, respiratory obstruction	1 yr.	Esophagoscopy. Excision of lesion and closure of mucosa. Proved diagnosis	22 mos.

leiomyomas of the esophagus are 6 times more common than leiomyosarcomas. A positive diagnosis, therefore, will aid in determining the extent of resection.

In general, the same histologic criteria of malignancy hold in leiomyosarcoma as in other malignant tumors; yet, some which are histologically malignant may be relatively benign clinically.

The histologic proof of the active degree of malignancy may be difficult to establish. Resection of the primary lesion, even in the presence of local metastases, to relieve obstruction is justified since many of these tumors are slow growing. The characteristic rapid progress of a sarcoma which usually terminates in early death does not occur in most leiomyosarcomas of the esophagus. The course of these tumors is incipient and usually not fatal in the untreated patient until late.

SUMMARY

1. Leiomyosarcoma of the esophagus is a relatively rare lesion; however, leiomyoma of the gastrointestinal tract occurs fairly frequently.

2. There have been 20 cases of leiomyosar-

coma of the esophagus reported, and an additional case has been added to these.

3. As a rule, the symptoms are directly related to the size and location of the tumor and, for the most part, are primarily accompanied by obstruction.

4. The diagnosis should be suspected in a patient who has dysphagia of any duration. An esophagoscopy and a barium swallow are necessary to confirm the presence of this condition.

5. A biopsy of the suspected lesion may prove beneficial in making a diagnosis and permitting a clear decision as to the type and extent of the surgery.

6. In view of the relatively low grade malignancy of these lesions, if resected early, the results should be good. A simple resection will be sufficient if the tumor is a benign leiomyoma.

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MEDIASTINAL LYMPH NODE PUNCTURE THROUGH THE TRACHEAL CARINA

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In 1949, an original method for thoracic exploration was described consisting of endoscopic puncture of the tracheobronchial mediastinal lymph nodes through the tracheal carina (1).

The classical descriptions of thoracic lymph nodes made by Sukiennicow and Rouvière were reviewed at that time and through surgical and necroscopic studies we were able to establish the fact that the incidence of infarcts of the inner tracheobronchial lymph nodes in many pathologic processes of the lungs, pleura, esophagus, and mediastinum was greater than that of such infarcts affecting the pericardium, thoracic wall, and lymphatic system.

When the lymph nodes are affected the tracheobronchial carina seen through the endoscope appears to be enlarged, deformed, rotated, and less mobile. However, all these alterations are not pathognomonic of the underlying lymphatic infarct since they can be observed in cases of traction due to chronic inflammatory diseases or in a variety of compressions.

The lymph nodes of this region were found in various sized spaces extending between the tracheal bifurcation above and the bifurcation of the pulmonary artery and the left auricular artery below. Since some necropsy specimens, especially those of peripheral bronchogenic carcinoma, clearly showed metastasis to the lymphatic region and its intimate contact with the tracheal carina, the endoscopic examination was supplemented by performing a puncture through the deformed carina with a long needle to aspirate lymphatic material for histologic study.

TECHNIQUE

To the standard endoscope is added a 50 centimeter by 1 millimeter puncture needle of universal cone and short bevel with its corresponding mandrel—which have been properly sterilized. This needle has been improved by others by adding a thicker coating to within 5 centimeters of its tip, giving it greater rigidity.

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Once endoscopy has been performed (Fig. 1) and the bronchoscope placed in front of the deformed carina, a local anesthetic is applied with a swab over the surface of the area to be punctured and 90 per cent alcohol is used as an antiseptic and mild anesthetic. The needle with its corresponding mandrel is inserted, and the carina is punctured (5 to 8 mm.). The mandrel is then withdrawn, and the needle is attached to the syringe which has been properly sterilized. As the needle always with the syringe attached is pushed in for 2 or 3 centimeters, fluid is gently aspirated (Figs. 2 and 3). No blood should be aspirated, and if bleeding occurs the needle

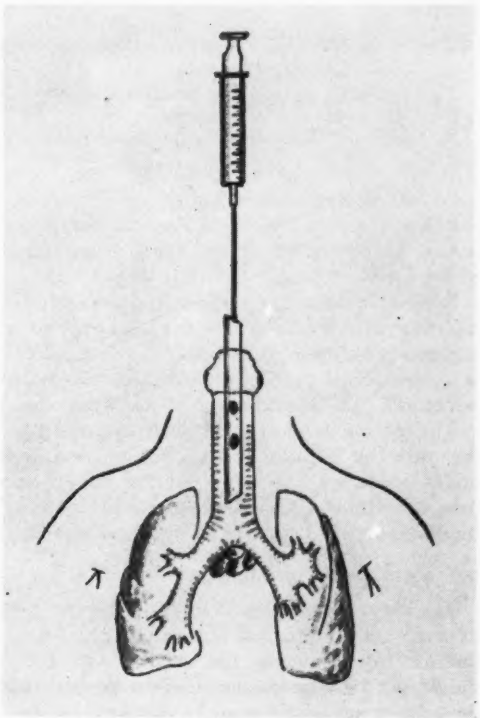

FIG. 1. Bronchoscope in front of the tracheal carina. Needle ready for use in performing puncture.

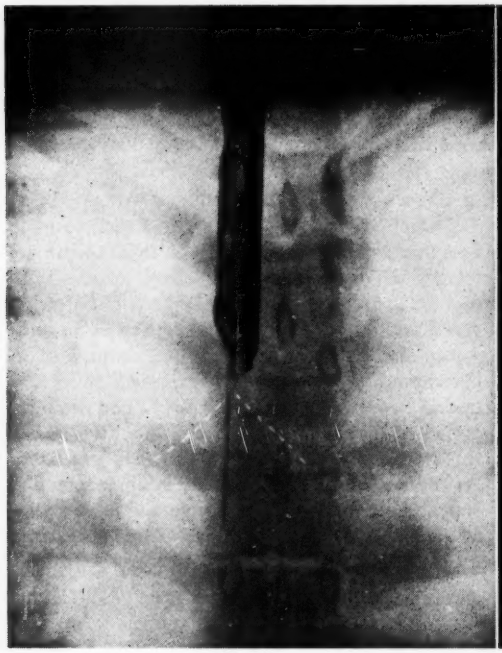

FIG. 2.

FIG. 3.

FIG. 2. Roentgenogram showing view of terminal end of bronchoscope and needle penetrating the carina into the lymphatic matter.

FIG. 3. Lateral view of same patient as in Figure 2.

must be removed at once. As soon as the needle has been inserted 2 to 3 centimeters, aspiration is ended and the entire apparatus is carefully withdrawn.

Aspiration is accomplished by inserting the aspirator into the lumen of the trachea, and a hemostatic solution of 30 per cent silver nitrate is applied locally over the area that has been punctured. The bronchoscope is then removed.

The needle is withdrawn from the syringe; the material aspirated from the mediastinal nodes is washed with saline solution into a test tube containing 10 per cent formalin ready for the pathologist to prepare in the usual manner.

COMMENTS ON THE TECHNIQUE

The carina is punctured with the needle and its mandrel to prevent tracheobronchial epithelium from entering the needle. Aspiration should not be done at the time the needle and the syringe are withdrawn. In this way, no mediastinal matter is aspirated into the trachea, and the introduction of cells and mucus into the needle is avoided. Cleaning by means of aspiration is later done at the site of the puncture and a solution of silver nitrate is applied locally to obtain a hemostatic effect and caustic action, and to prevent any possible contamination of the tracheal mucosa. Generally, several histologic sections are required since the material obtained is scarce and the biopsy might indicate a falsely negative result. Control bronchoscopy was performed on several patients at different intervals and no alteration was seen either immediately or later that could be attributed to this method of exploration.

Exploration performed according to this technique involves minimal risk, or none at all. It might be wiser, however, not to perform it in the presence of possible widespread soft tuberculous mediastinal disease.

RESULTS AND COMMENTS

In the last 7 years, 83 patients were subjected to mediastinal punctures through the tracheal carina. In 69 patients, puncture was performed

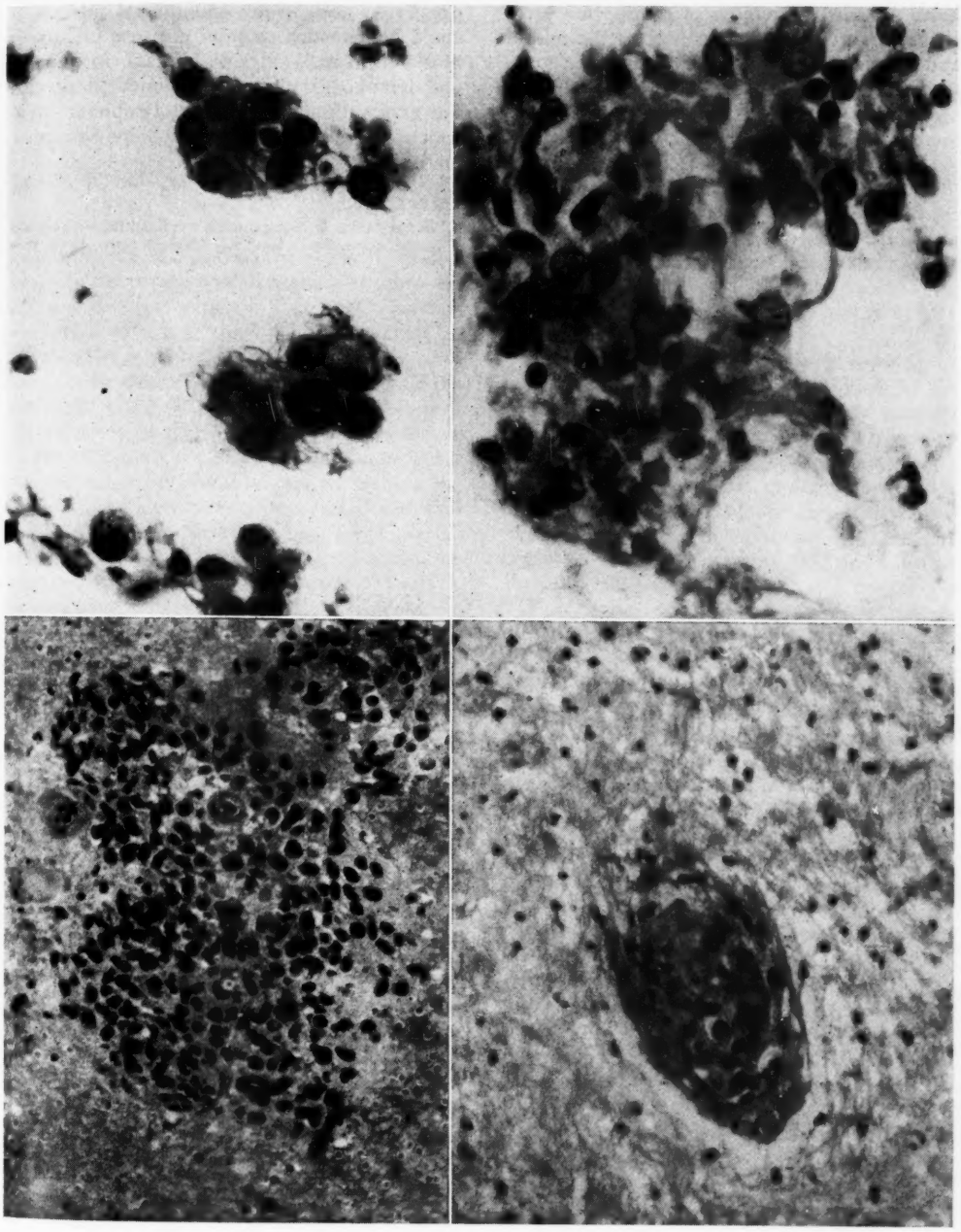

FIG. 4. Photomicrographs showing neoplastic flaps and cells in material obtained by puncture.

as an aid in the diagnosis of a suspected bronchogenic carcinoma or a cancer of the middle and inferior thirds of the esophagus. In 26 of these 69 cases, positive histologic data established a diagnosis of cancer (Fig 4) and in some of them even the histologic type was determined.

In cases of cancer of the lung or esophagus, this method, which broadens the scope of endoscopy, often permits an accurate diagnosis and prognosis, since it clearly shows the range of the mediastinal invasion. This method is free of great risks and, in my opinion, its application could be extended to other diseases; i.e., mediastinal tumors, Hodgkin's disease, sarcoidosis, and lymphogranulomas. This method permits the exploration of important lymphatic areas which are difficult to approach by any other method.

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THE TREATMENT OF PARALYTIC ILEUS WITHOUT THE USE OF GASTROINTESTINAL SUCTION

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PERISTALSIS CEASES, or becomes markedly diminished, in the presence of peritonitis or following major abdominal surgery. This finding, which may occur reflexly in other conditions of less interest to the surgeon, is known as paralytic ileus and is easily recognized upon auscultation of the abdomen. Paralytic ileus assumes added importance if accompanied by abdominal distention.

The treatment of this condition has included enterostomy, abdominal stupes, parasympathomimetic drugs, enemas, oxygen inhalation, and spinal anesthesia. Although some surgeons rely on these methods of therapy as adjuncts, the most universally accepted treatment of paralytic ileus is gastrointestinal suction.

Unfortunately, gastrointestinal intubation is not an innocuous procedure. There are disadvantages inherent in this method of treating paralytic ileus which warrant close scrutiny. The intubated patient is subject to a series of complications ranging from simple discomfort because of a dry mouth and sore throat to severe respiratory problems, esophageal ulceration and stricture, and perforation of the upper intestinal tract. Chaffee and Farris have listed these complications and commented on the relationship between morbidity and nasogastric suction. Farris advocated gastrostomy decompression postoperatively as a means of lowering the incidence of suction tube complications. In rare instances these complications, or the surgical procedures necessary for their correction, have led to the demise of the patient.

Nasogastric suction also complicates the postoperative care of the patient by making it more difficult to maintain fluid and electrolyte requirements. The necessity for replacing the aspirated gastrointestinal secretions has been adequately stressed by Randall and by Taylor, but no intravenous solution devised can exactly replace the physiologic fluid emptied from the suction bottle each day. Water and electrolyte loss via biliary drainage, ileostomy, or diarrhea may be unavoidable, but loss due to nasogastric suction is clearly iatrogenic.

Because of these objections, we have reviewed the rationale of gastrointestinal suction for the treatment of paralytic ileus. The mere presence of a tube in the gastrointestinal tract has never been shown to promote peristalsis, and there is no logical reason why it should. Therapeutic suction can only serve the purpose of preventing or relieving abdominal distention. This, in turn, is accomplished by aspirating fluid and gas from the intestinal tract.

Fluid. The normal sized adult secretes approximately 8,000 milliliters of fluid daily into the digestive tract; this is made up of saliva, gastric juice, bile, pancreatic secretions, and succus entericus. Observers have differed regarding the volume of postoperative intestinal secretions, but apparently this varies little from the normal; in the presence of distention, however, the volume may be significantly increased as demonstrated by Landor. Although larger amounts may be removed if the tube is religiously attended by a special nurse, it has been our experience that from 500 to 1,000 milliliters of fluid are obtained daily by nasogastric suction from patients with paralytic ileus. This is usually replaced by 1,000 milliliters of a parenteral solution. One may then ask what has happened to the other 7,000 milliliters of digestive tract secretions. Obviously, no patient could long survive such a loss of fluid into the third compartment; moreover, when we consider that suction frequently is maintained for 3 days or longer, it would suggest that all, or almost all, of the intestinal secretions are reabsorbed.

If this premise is correct, the intestinal tract should also be able to reabsorb the small fraction of total secretions removed by the suction tube. It is possible that gastrointestinal secretions are decreased in the presence of paralytic ileus, and,

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TABLE I.—PARALYTIC ILEUS TREATED WITHOUT NASOGASTRIC SUCTION IN 300 CONTROLLED CASES

	No. of cases	
Biliary tract		71
Cholecystectomy	27	
Cholecystectomy and common duct exploration	12	
Common duct exploration	5	
Cholecystectomy and common duct exploration and sphincteroplasty	5	
Sphincteroplasty	1	
Cholecystectomy, emergency	9	
Cholecystectomy and common duct exploration, emergency	2	
Cholecystostomy	7	
Roux-Y cholecystojejunostomy and gastroenterostomy	3	
Gastric		36
Subtotal resection	31	
Subtotal resection and cholecystectomy	1	
Gastrotomy	3	
Pyloroplasty	1	
Perforated peptic ulcer		11
Simple closure	8	
Subtotal resection	1	
Vagotomy and pyloroplasty	2	
Vagotomy		23
Vagotomy, simple	1	
Vagotomy and pyloroplasty	17	
Vagotomy and pyloroplasty and repair hiatus hernia	2	
Vagotomy and subtotal gastrectomy	2	
Vagotomy and pyloroplasty, repair hiatus hernia, and cholecystectomy	1	
Colon		36
Colectomy on the left side	5	
Sigmoid resection	8	
Sigmoid resection and cecostomy	1	
Sigmoid resection and closure sigmoid-vesical fistula	1	
Colectomy on the right side	4	
Closure colostomy	2	
Colotomy and polypectomy	1	
Abdominoperineal resection	10	
Colostomy	4	
Appendicitis, perforated with peritonitis		21
Appendectomy	21	
Pelvic inflammatory disease		3
Pelvic inflammatory disease with peritonitis	3	
Small intestinal obstruction, tube removed after surgery		46
Simple strangulated hernia	13	
Simple adhesive band	21	
Gangrenous, strangulated hernia, bowel resection	3	
Gangrenous, adhesive band, bowel resection	5	
Gallstone ileus, enterotomy for removal	1	
Ileotransverse colostomy for cancer	3	
Large intestinal obstruction, tube removed after surgery		7
Transverse colostomy	5	
Tube cecostomy	1	
Cecostomy	1	

TABLE I.—PARALYTIC ILEUS TREATED WITHOUT NASOGASTRIC SUCTION IN 300 CONTROLLED CASES—Continued

	No. of cases	
Gunshot wound, abdomen		6
Negative	2	
Suture, stomach and small intestine	1	
Suture, liver, stomach, diaphragm, and splenectomy	1	
Suture, liver, stomach, and small intestine	1	
Suture, stomach, partial pancreaticoduodenectomy	1	
Stab wound, abdomen		16
Negative	9	
Splenectomy	1	
Suture, stomach	1	
Suture, small intestine	1	
Suture, transverse colon	1	
Suture, transverse colon and small intestine	1	
Suture, kidney	1	
Suture, liver	1	
Crush wound of abdomen		4
Lacerated liver, retroperitoneal hemorrhage, fractured spine	1	
Laceration of sigmoid, loop colostomy	1	
Ruptured spleen	2	
Pancreatitis		6
Acute pancreatitis	5	
Roux-Y pancreaticojejunostomy	1	
Diaphragmatic hernia		3
Repair hiatus hernia	2	
Repair hiatus hernia and splenectomy	1	
Arteriosclerosis		2
Lumbar sympathectomy	2	
Duodenal polyp		1
Polypectomy	1	
Aortic aneurysm		2
Resection and homograft	2	
Sigmoid diverticulitis		2
Exploratory laparotomy	2	
Meckel's diverticulitis		1
Diverticulectomy	1	
Exploratory laparotomy		3
Extensive manipulation of intestines	3	

indeed, diminished gastric secretion has been noted by Eade. However, irrespective of the volume of secretion formed, aspiration of this fluid renders the maintenance of water and electrolyte balance more difficult.

Gas. The second, and most important, function of the suction tube in the management of paralytic ileus is the aspiration of gastrointestinal gas. This is accomplished by removing from the stomach what Wangensteen has shown to be the chief source of intestinal gas, swallowed air. However,

except for the small percentage of people who are pathologic aerophagics, important amounts of air are swallowed only with the act of deglutition. The patient who is on "nothing by mouth" swallows little air that cannot be handled by the intestinal tract. Gerber has demonstrated this fact in infants with x-ray studies of the abdomen before and after sucking on an empty nursing bottle. From a clinical evaluation of postoperative adults, Begg has made similar observations. Despite Maddock's claim that nervous or apprehensive individuals become temporary aerophagics, Alvarez states "one can examine hundreds of patients fluoroscopically before finding one with enough air in the stomach to excite remark."

We have observed that patients with paralytic ileus swallow little air when oral intake, including water, is strictly prohibited. A diet is ordered for the postoperative patient only when he manifests one important sign that paralytic ileus is no longer present—a resumption of peristalsis. This condition is usually accompanied by hunger and the passage of flatus. The present study was undertaken to determine whether continuous aspiration of fluid and gas served a useful purpose in the treatment of paralytic ileus.

On the basis of our experience, one of the surgical services at the Los Angeles County General Hospital eliminated nasogastric suction in the treatment of paralytic ileus in January 1956. As confidence was gained, this policy was extended to other surgical wards. Now, 1,000 patients with paralytic ileus have been treated without gastrointestinal suction. These include all types of stomach, colon, and biliary tract surgery; gunshot and stab wounds of the abdomen; and cases of peritonitis due to perforated appendicitis, perforated peptic ulcer, and acute pancreatitis. We have found that this method of treatment does not delay the return of peristalsis in patients with paralytic ileus.

During this study, 300 consecutive cases of paralytic ileus in which suction was withheld were compared with 300 similar cases in which some form of intestinal suction was used. These groups roughly paralleled each other in the magnitude of surgery performed. Only patients undergoing major operations were included in this study (Table I). The patients from whom suction was withheld were more comfortable, were more easily maintained in water and electrolyte balance, and required less nursing care than the intubated patients. In this small, controlled series the mortality and morbidity statistics of the patients treated without suction compared favorably with the controls. Of special interest in this series is a group of 25 patients with peptic ulcer (including 2 with an acute perforation) treated by vagotomy but without postoperative suction. No disadvantage from lack of gastric decompression was noted in this group.

TABLE II.—RESPIRATORY TRACT COMPLICATIONS ENCOUNTERED IN 300 PATIENTS TREATED WITH AND 300 PATIENTS TREATED WITHOUT A TUBE

	Tube	*No tube*
Atelectasis	7	1
Pharyngitis*	7	0
Bronchitis†	13	0
Pneumonia	15	8
Sinusitis	1	0
Total	43 (14.3 per cent)	9 (3 per cent)

*Sufficiently severe to require active treatment.
†Excess secretions necessitated a tracheotomy in 2 patients.

There were 36 deaths (12 per cent) in the intubated series and 23 deaths (7.6 per cent) in the nonintubated series. The higher mortality rate in the first group is not significant since no death was directly due to the use of a suction tube. On the other hand, no mortality in the nonintubated series of patients could be attributed to lack of nasogastric suction.

A more revealing picture is evident in Table II. There were 43 (14.3 per cent) respiratory tract complications in the intubated series and 9 (3 per cent) in the nonintubated group. The distinctly higher incidence of respiratory tract complications in the intubated series is not surprising. The irritating property of suction tubes is forcefully shown by the invariable glob of thick, tenacious mucus clinging to their outer surfaces.

Interestingly, we found that patients frequently vomit small amounts of bile (10 to 90 c.c.) following biliary tract surgery. However, the incidence of this reflex vomiting is not lowered by nasogastric suction. In the nonintubated series, 21 of 71 patients undergoing biliary tract surgery vomited (29.5 per cent). Seventeen of 56 intubated controls vomited around the tube (30.3 per cent).

An occasional patient has been subjected to intermittent gastric aspiration to confirm the absence of gastric dilatation. Acute gastric dilatation, with its picture of shock, has not been seen in the nonintubated cases; this dreaded complication apparently occurs infrequently when oral intake is withheld. In 1 patient moderate gastric

dilatation developed while receiving oxygen via nasal catheter. In this instance, we believe the catheter was down too far. It is probably wise to use gastric decompression in patients maintained on oxygen in this manner. If oxygen is administered by face mask, nasogastric suction is unnecessary.

SUMMARY AND CONCLUSIONS

One thousand patients with paralytic ileus have been successfully treated without nasogastric suction.

The advantages of this method of treatment are apparent when 300 patients with paralytic ileus from whom suction was withheld are compared with a control series treated by gastrointestinal suction.

The nonintubated patients recovered from the ileus as quickly as the intubated patients.

The morbidity of the intubated series was distinctly increased; especially noteworthy was the higher incidence of respiratory complications.

Maintenance of fluid and electrolyte balance and nursing care were simplified in the nonintubated patients.

It is mandatory that *all* oral intake be withheld from patients with paralytic ileus if nasogastric suction is withheld.

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GENERAL HYPOTHERMIA WITH INTRAGASTRIC COOLING

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F. JOHN LEWIS, M.D., Chicago, Illinois

THE PRESENT TECHNIQUES for induced hypothermia in surgery are not completely satisfactory. Water immersion for cooling and rewarming is inconvenient and troublesome since the patient must be moved at critical steps in the procedure. Cooling by blood shunting is an effective but somewhat difficult technique. Surface cooling and rewarming with a thermic blanket is a practical but slow procedure, especially in the rewarming phase. Furthermore, it provides only limited temperature control during surgery in operations requiring wide exposure. Diathermia has been used in the rewarming phase, but it demands considerable care in order to avoid burns.

Searching for a better technique, we became interested in the use of an intragastric device which could be used in conjunction with thermic blankets and which could control the temperature of the patient during the actual performance of the operation. As previously reported by Khalil in 1954 and Barnard in 1956, a balloon can be safely introduced into the stomach of a patient without deleterious effects, as determined by means of clinical observation and histologic studies.

The utilization of the stomach as a medium for internal thermic control is made attractive by a number of facts. The stomach is a richly vascular organ. It lies in close relation to viscera which have high rates of blood perfusion, and it is in relatively close proximity to the vessels through which flows half of the body's blood. The cooling of this large volume of blood permits the use of a small temperature gradient to effect change in the body temperature. In the light of these facts, we devised an apparatus through which a constant volume of water of a controlled temperature is circulated by means of a finger-type pump. It employs the same refrigerating apparatus which is simultaneously used for surface cooling.

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MATERIAL AND METHODS

The gastric device consists of a coil of plastic tubing immersed in the fluid tank of a Therm-O-Rite machine, a thermometer which measures the temperature of the circulating fluid, an esophageal tube at the end of which is connected a multilayered balloon, and a Sigmamotor pump which circulates the fluid through the system. Figure 1 schematically shows the assembled apparatus. The intragastric portion of the apparatus, as seen in Figure 2, is divided into 3 sections. The esophageal section consists of a plastic tube 60 centimeters long of ⅜ inch internal diameter through which are passed 2 polyethylene tubes. The middle section is an adapter through which also pass the 2 polyethylene tubes. The necks of the balloons are tightly compressed between the adapter and the esophageal tube to provide a fluid-tight connection. The gastric section is a further extension of the polyethylene tubes surrounded by a short piece of tube of ⅜ inch internal diameter at the end of which is inserted a rounded plug. The 2 polyethylene tubes and the external plastic tube are perforated along their entire length to provide an outlet and inlet for the circulating fluid. This section is surrounded by 3 large rubber balloons to form a closed and elastic chamber.

To operate, the system is filled with 600 cubic centimeters of water by way of a T tube (Fig. 1) and all the air is removed by circulating the water for several minutes leaving the balloon deflated and ready for insertion. After endotracheal intubation of the patient, the lubricated balloon is placed within the stomach. To distend the balloon, an additional amount of water (600 c.c.) is introduced into the system by way of the T tube using a syringe. The pump is then started, and circulation is maintained at a rate of approximately 2 liters per minute. The water is kept at 6 degrees C. by circulating it through plastic coils immersed in the fluid of the tank the temperature of which is −4 degrees C. Cooling is halted when the patient's rectal temperature reaches 3 to 4 degrees C. above the de-

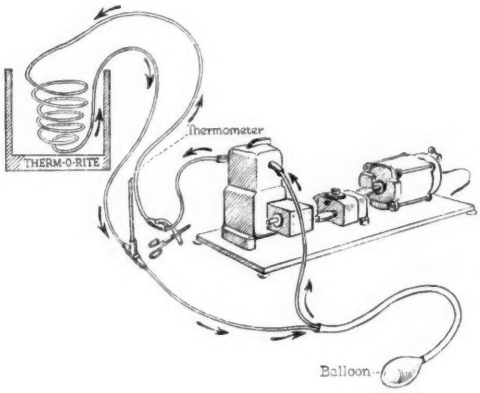


FIG. 1

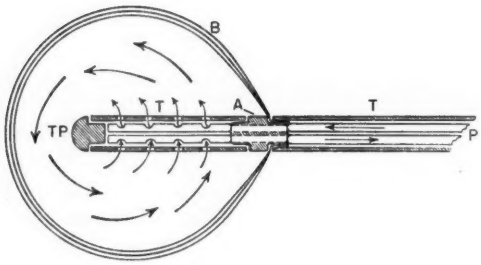


FIG. 2

FIG. 1. Schematic drawing of the assembled apparatus.
FIG. 2. Schematic drawing of the intragastric portion of the device. *B*, Balloons; *T*, tube; *P*, polyethylene tubes; *A*, adapter; *TP*, plug.

sired temperature. When to begin rewarming is determined by the length of the operation and drift of the patient's temperature, but in any case, effective rewarming is started before the operation is completed. During the rewarming phase, the circulating water is heated to 42 degrees C. by elevating the temperature of the fluid in the tank to 46 degrees C.

EXPERIMENTAL DATA

Before using the apparatus on patients, experiments were performed on dogs in order to study possible dangers and to obtain comparative data on separate and combined procedures. Eleven mongrel dogs weighing between 22 and 44 pounds were used in 18 experiments. Four dogs were cooled or warmed by intragastric means only, in order to determine the effect of relatively extreme temperatures on the gastric structure. Of this group, 2 dogs were cooled by circulating water through the gastric balloon at 4 degrees C. for 90 minutes, and the remaining 2 were warmed, also for 90 minutes, with water at 65 degrees C. All 4 dogs were sacrificed, and specimens of the stomach were taken 2 days after the procedure. All of the remaining 7 dogs were subjected to the following experiments: (a) cooling and warming by intragastric balloon in addition to thermic blankets, and (b) with blankets alone. The temperature of the fluid circulating through the balloon during the cooling phase was 11 degrees C.[1] and that through the blankets −6 degrees C. During rewarming, the temperature was 46 degrees C. for both balloon and blankets.

The following results were obtained: When the gastric balloon was used in combination with thermic blankets, the rate of temperature change was 2 to 3 times more rapid than with blankets alone. The rectal temperature of the dogs rose and fell in a linear fashion in all 3 types of experiments. With blankets alone, the temperatures fell at the average rate of 1 degree C. each 17.5 minutes, while a combination of blankets and balloon decreased the average time to 6.9 minutes for each degree of fall. Similarly, in rewarming, an average of 18.7 minutes were required to raise the temperatures 1 degree C. when only blankets were used, whereas only 9.8 minutes were necessary when the balloon was used in addition to the blankets (Figs. 3 and 4). Histologic studies of the 4 dogs submitted to extreme temperatures showed no damage of gastric mucosa.

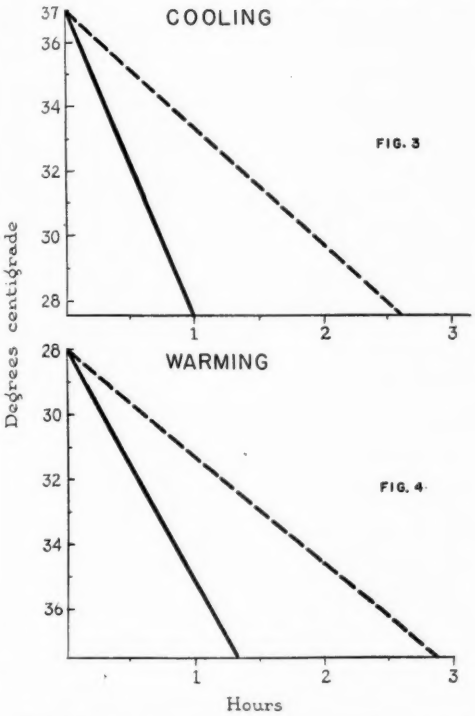
CLINICAL STUDIES

The following clinical data were obtained from patients divided into two groups. A different cooling-rewarming technique was used in each.

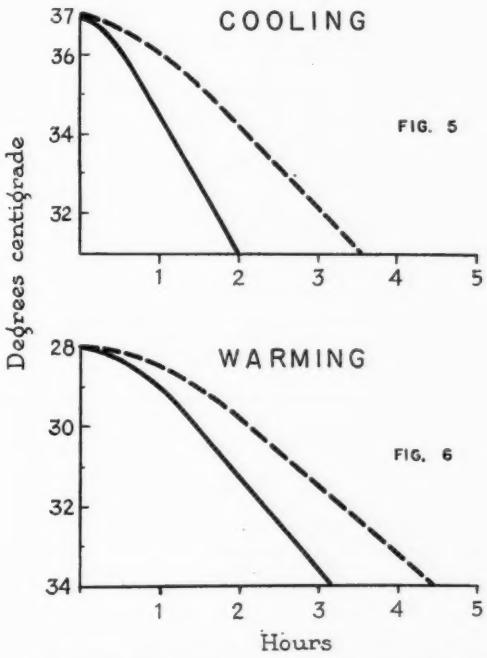
Group A consisted of 6 patients who were subjected to hypothermia by using the gastric balloon in addition to the usual thermic blankets. Three of these patients underwent cardiac surgery and 3 had craniotomies for neurologic disease. One of the 3 neurosurgical patients was included in this group and in group B since he was cooled by blankets alone in a later operation.

The patients of group B were cooled by blankets alone. This group consisted of 1 neurologic and 4 cardiac surgical patients. The average

[1]In these experiments the water was cooled by immersion of the plastic coils in a bucket of ice water, which was 6 degrees C. warmer than the tank.



FIGS. 3 and 4. Rate of rectal temperature change in 7 dogs during cooling and rewarming with blanket (dashed line) and with gastric balloon and blanket combined (solid line).



FIGS. 5 and 6. Rate of rectal temperature change in 4 patients during cooling and warming with blanket (dashed line) and, in 6 patients, with gastric balloon and blanket combined (solid line).

weight of these patients (selected according to weight from a larger group) was comparable to the average of group A, 150 pounds.

The cooling-rewarming procedure in both groups followed the same general scheme. During cooling the temperature of the gastric balloon was 6 to 8 degrees C. and that of the blanket −4 degrees C. in both procedures. Cooling was stopped when the patient's temperature was 3 to 4 degrees C. above the desired temperature. The average minimum temperature of the two groups combined was 28.3 degrees C., ±1.3 degrees C. Following cooling, the average temperature drift was 3.6 degrees C. during a 2 hour period. To rewarm the patient, the temperature of the gastric balloon was maintained at 42 degrees C. and that of the blankets at 46.

The use of a gastric balloon clearly hastened body cooling and rewarming. In both procedures, the patient's temperature changed in a curvilinear fashion. With blankets alone, the temperature fell at an average rate of 1 degree C. every 35.2 minutes, while with the gastric balloon in addition, the average was 1 degree C. every 19 minutes. On rewarming with blankets only, the patient's temperature rose at an average rate of 1 degree C. every 44 minutes; with gastric balloon and blankets, 1 degree C. every 31.7 minutes (Figs. 5 and 6).

In 6 patients cooled by the gastric device, there were no unusual changes in electrocardiographic patterns, blood pressure, or heart rate. These patients showed no postoperative evidence of gastritis or mediastinitis. Pepsin and hydrochloric acid titer tests were done on 3 patients and no changes were found.

DISCUSSION

The use of an intragastric device in hypothermia has proved safe, reasonably simple, and

effective with dogs and in a series of patients. The introduction of the gastric balloon can be accomplished without difficulty or danger of trauma because of its flexibility, smoothness, and relatively small diameter.

As demonstrated by histologic studies on experimental animals, clinical observations, and laboratory determinations, no damage to the stomach was produced. The temperature range of the fluid circulating in the balloon is kept within the safe range of 3 to 42 degrees C.

A closed system was preferred to the open circuit originally used by Barnard because of the following safety feature: The system contains 1,200 cubic centimeters of water, only a half of which would be released into the stomach if the balloon should rupture. In this event, further distention of the stomach would be impossible since the system remains essentially closed. The pump would continue to work effectively only as long as water was available in the stomach to be drawn out, circulated through the coils, and returned to the stomach. When the balloon was experimentally ruptured while in the stomach of a dog, the suction tubing between the pump and the balloon collapsed immediately as the escaped water passed into the small intestine leaving the stomach empty. The resulting collapse of the suction tube is due to the construction of the terminal portion of the gastric device which causes coverage of the suction pores by the collapsed balloon. However, the likelihood of an intragastric rupture is minimized by the use of a multilayered balloon, as seen in Figure 2. In the 20 applications to date there have been no ruptures.

The gastric device can be easily constructed and assembled, and it occupies little space in the operating room. The major expense of the device is the pump.

In both the experimental and clinical application the combined use of balloon and blankets consistently shortened the period required for cooling and warming with blankets alone. With more rapid cooling and rewarming the patient is subjected to abnormal body temperatures for shorter periods of time. In all 6 operations in which the gastric device was used, the patients' temperatures were 34 degrees C. or higher at the completion of the operation.

An additional advantage in the use of the gastric cooling was observed in a recent thoracic aorta aneurysm repair in which the patient was lying on his side during the entire procedure. Such positioning ordinarily results in a decrease in the area of contact between the body and blankets which permits poor temperature control. In this case, however, the patient's temperature was lowered, maintained at 31.6 degrees C. ± 0.3 degrees C. for 3 hours, and raised to normal by the use of the gastric device and a single lower blanket.

SUMMARY

1. In experimental animals, the use of a gastric device in combination with external blankets significantly decreased the time required for cooling and rewarming, compared with the results obtained when blankets alone were used.

2. Histologic examinations of the gastric mucosa of dogs subjected to extreme temperatures (65 to 3 degrees C.) for prolonged periods showed no damage.

3. On clinical application, the gastric device reduced the cooling time by almost one-half and the rewarming period by one-fifth.

4. Clinical observations and laboratory studies demonstrated no alteration of gastric function.

5. By using the combined procedure, the temperature of the patient was returned to a safe level (above 34 degrees C.) on or before the completion of the operation.

6. The gastric device proved to be especially useful in situations in which the body contact with blankets was limited because of special positioning of the patient.

7. The described gastric apparatus is simple to assemble and operate, and occupies little space in the operating room.

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THE SURGEON'S LIBRARY

Reviews of New Books

THE STORY of a great institution in New York City, one which has played a very important part in the evolution of medicine and surgery in that city, as well as in this country, is related in the volume entitled *The Roosevelt Hospital 1871-1957*.[1] It is especially interesting for one who began his internship in that hospital 50 years ago, for at that time it was at the height of its reputation in its association with the College of Physicians and Surgeons, situated across from it on West Fifty-Ninth Street.

Few hospitals have had such a roster of eminent doctors and teachers. Among the physicians were Alonzo Clark, Willard Parker, Francis Delafield, Walter B. James, and Evan Evans. Among the famous surgeons were Henry B. Sands, Thomas M. Markoe, William T. Bull, William S. Halsted, Robert F. Weir, Charles McBurney, Joseph A. Blake, and Charles E. Brewer. The part all of these men played is recorded in the history of medicine and surgery in this country.

The volume is made up of factual data regarding the family of the founder of the hospital and the evolution of the plant itself from the first structure to the many others that have been added to it. Some of these, like the Syms Amphitheatre which once was considered the last word in operating room space and equipment, have been dismantled for other purposes. The rest of the history is made up of reminiscences by former interns, residents, and hospital personnel. These vary considerably in content and interest. By far, the most humorous and reminiscent, as well as critical of the attending physicians and surgeons, is written by Dr. Edwards A. Park, Emeritus Professor of Pediatrics at the Johns Hopkins Medical School. His experiences on the old ambulance and in the accident ward, as well as his descriptions of the men he worked with and others of the personnel are delightfully told. His accounts of the dreadful routine which was followed in the early decade of this century in treating typhoid patients, and the way many patients were dosed with now unheard of prescriptions, make one wonder why so many of the sick survived.

This history was published at the request of the Medical Board of the Roosevelt Hospital, and was prepared by Dr. Condict W. Cutler, Jr., Dr. Alexander T. Martin, and Dr. Thomas C. Peightal, all three former interns and later attendings of the hospital.

—*Allen O. Whipple.*

[1]THE ROOSEVELT HOSPITAL 1871–1957. 358 pages, illustrated. New York: The Roosevelt Hospital, 1957.

THE FIRST FEW CHAPTERS in the fifth volume of *Operative Surgery*[2] deal with basic surgical technique, the care and use of orthopedic instruments, bone grafts of all types, and the various materials used for internal fixation. The brief, preliminary introduction by J. Crawford Adams should be reviewed many times by all surgeons who do not confine their entire practice and time solely to orthopedic surgery.

A section is devoted to each of the major regions of the musculoskeletal system, and the major operative procedures performed in each of these regions are carefully presented by authors who already are well known and respected in the United States, as well as in England. The composition of each subject is uniformly presented and copiously illustrated in a concise, accurate, and complete manner, which makes this book most unusual and valuable. In each chapter preoperative indications and considerations, anesthesia, surgical preparation, and also postoperative care, contraindications, and complications are carefully, but briefly, given. The body of the chapter contains a careful step-by-step descriptive and illustrated discussion of the operation. Variations of the procedures, as the indication arises, are adequately presented.

One criticism we might offer is that the individual surgical procedures are so beautifully and simply described that a surgeon not adequately trained and experienced may feel free to undertake a major orthopedic operation which he may not find in practice to be quite so simple. To name a few: the Putti-Platt or the Bankhart operations for recurrent dislocations of the shoulder, the triple arthrodesis and its variations, and the various operations about the hip technically are difficult operative procedures. Certainly, the chapters are complete and accurate but must be combined with a complete and accurate knowledge of the anatomy, the underlying pathology, and the ability to correct this pathologic condition by the surgeon and not to be forced to make a problem fit only a surgical procedure. This latter objective can only be gained with experience, and this volume contributes a careful guide to a complete understanding of the basic surgical principles.

—*William J. Schnute and Walter G. Maddock.*

[2]OPERATIVE SURGERY. Edited by Charles Rob, M.C., M. Chir., F.R.C.S., and Rodney Smith, M.S., F.R.C.S. Vol. V, ORTHOPAEDIC SURGERY. 371 pages, illustrated. London: Butterworth & Co., Ltd., 1957.

THE BOOK *Gastro-Duodenal Ulcer; Physio-Pathology, Pathogenesis, and Treatment*[3] is primarily an analysis of the vast literature dealing with the pathogenesis of gastric and duodenal ulcer, the secretary and motor physiology of the stomach, the role of fat in the economy of the organism, together with brief comments on the medical and surgical treatment of chronic peptic ulcer. The extensive bibliography is a distinct service to the investigator and to the student in this field. Most of the references are alluded to in the text and the significance of each contribution discussed. On the whole, this is well done, although in many instances the studies referred to are incompletely analyzed and the most significant evidence in the papers omitted. This has led to the surprising statement: "It may be stated emphatically that there is no evidence whatsoever that a chronic lesion has been produced experimentally by hydrochloric acid or by the pepsin hydrochloric acid combination in the acid bearing area which in any way resembles the chronic ulcer in man." Not many active investigators in the field would agree with this statement. Several sections of the book are devoted to the author's own theory of chronic ulcer formation. In the production of the ulcer, the author speculates that bile is the original stimulus which initiates the lesion, prevents it from healing, and maintains its chronicity. Acid, however, is important and its destructive effect is increased by previous contact of the mucosa with bile. Little or no experimental evidence is provided in support of this theory, but the author states that a number of dogs have been operated upon in such a way as to produce reflux of bile into the stomach. While the theory is interesting, these animals have not been observed long enough to know whether or not ulcers develop.

—*Lester R. Dragstedt.*

THE FIRST EDITION of the volume entitled *The Early Diagnosis of the Acute Abdomen* was published in 1921. Since then there have been ten printings including the latest eleventh edition[4] printed in 1957, evidence of the acceptance this volume has received from the medical profession. In the eleventh edition "the whole book has been revised and several important additions have been made."

In Chapter 1, "The Principles of Diagnosis in Acute Abdominal Disease," the author stresses the necessity of making a serious attempt at diagnosis, the importance of a thorough routine examination, and the knowledge of anatomy and physiology required.

In Chapter 4, entitled "Method of Diagnosis," the symptoms are grouped and problems such as abdominal pain by itself, pain with severe shock, and pain with increasing distention but no rigidity are discussed. A point stressed is the value of re-examination of the patient as often as is necessary.

The chapters on appendicitis and on its differential diagnosis are certainly most valuable. Reproductions of x-ray films illustrating complications of appendicitis as well as acute intestinal obstructive problems are included in this edition.

In Chapter 7, a discussion of perforated gastric or duodenal ulcers, the author divides the signs and symptoms into three stages, the first of which is the stage of prostration or primary shock. In this stage are listed various signs and symptoms such as livid or ashen appearance, cold extremities, cold sweating face, and small and weak pulse. Although many o these signs and symptoms may be present, a frank shocklike condition with actual fall in blood pressure is not necessarily part of the initial stage of an acute perforation of a duodenal ulcer.

In the chapter on ectopic gestation, the author makes a plea for early diagnosis and, if possible, prior to actual rupture.

In the chapter on early diagnosis of abdominal injuries, one might have devoted some additional consideration to the signs and symptoms of the ruptured spleen. Serial hematocrit determinations, roentgenologic evidence of fractured ribs on the left side and of opacity in the left lower lung fields, diffuse mild tenderness of the upper abdomen, and the value of paracentesis might also have been mentioned.

The reviewer can whole heartedly support the author's statement that the book can be of help to students, house officers, and particularly to men in general practice.

—*John H. Schneewind.*

THE BOOK entitled *The Care of the Expectant Mother*[5] was written as a "practical guide for all who undertake management of pregnancy." It is divided into three parts, the first deals with normal pregnancy. Included are chapters on anatomy and physiology of pregnancy, the clinical examination of the pregnant woman, special investigations which include pregnancy tests, blood groups and Rh factor, x-ray examinations, and routine laboratory procedures. In the last two chapters, the author discusses the care of the mother during pregnancy, preparation for childbirth, and the maternity service in Great Britain.

Part 2 deals with abnormal pregnancy, such as multiple pregnancy, malpresentations, disproportions and trial of labor, obstetric hemorrhage, and induction of labor.

In Part 3 the diseases complicating pregnancy are discussed in a concise manner. The management of these complications is quite similar to that used in the United States.

This volume should be of particular value to medical students and student midwives, and the preface states that much of its contents is based upon routine teaching given them. It gives much fundamental information to physicians practicing obstetrics.

—*M. P. Urnes.*

ONE OF A SERIES of fascicles from the Armed Forces Institute of Pathology which is entitled *Tumors of the*

[3]GASTRO-DUODENAL ULCER; PHYSIO-PATHOLOGY, PATHOGENESIS AND TREATMENT. By J. Jacques Spira. 549 pages, not illustrated. $14.70. London: Butterworth & Co., Ltd., 1956.

[4]THE EARLY DIAGNOSIS OF THE ACUTE ABDOMEN. By Sir Zachary Cope, B.A., M.D., M.S.(Lond.), F.R.C.S.(Eng.). 11th ed. 188 pages, illustrated. $4.50. London, Toronto, and New York: Oxford University Press, 1957.

[5]THE CARE OF THE EXPECTANT MOTHER. By Josephine Barnes, M.A., D.M. (Oxon.), M.R.C.P. (Lond.), F.R.C.S. (Eng.), F.R.C.O.G. 270 pages, illustrated. $7.50. New York: Philosophical Library, 1957.

Kidney, Renal Pelvis, and Ureter[6] is very helpful. The graphic written material is supplemented with photographs of patients, roentgenograms, gross specimens, and microscopic slides which together constitute a fine summation of the more common tumors. The two major malignant neoplasms of the kidney, adenocarcinoma and nephroblastoma, receive the greater amount of space. There is a thorough coverage of the frequently encountered nonmalignant neoplasms seen at routine autopsy. The infrequent connective tissue tumors are properly documented. Tables are used to describe the subjects in which they will prove most valuable. Bibliographies, based on more current publications, follow each section rather than the end of the text. This volume merits careful study by all physicians.

The format of *Tumors of the Pituitary Gland and Infundibulum*[7] resembles that of the other fascicles in this series. The major sections are devoted to the adenomas with most of the space concentrated on the chromophobe variety. There is a thorough review of the histology at the introduction. Some of the photomicrographs are in color—most are in black and white. Tables are used, and there is one chart showing restriction of peripheral fields. When indicated, cases are used to bring about clinical correlation. Especial reference is made to the relationship of pituitary tumors with the brain and the optic chiasm, to a lesser extent with the hypothalamus. The description of adamantinoma in the stalk is worth reading by everyone. The bibliography, at the end, is well chosen.

The fascicle entitled *Tumors of the Eye and Adnexa*[8] is of the same high level of competence as the other volumes. Dr. Reese has used some of the material from his previous text published by Hoeber and has supplemented it with other cases. Emphasis is placed upon photographs and photomicrographs. Most of these are in black and white while a few are in color. The greater amount of space is devoted to the eyeball proper. As one would expect, the retinoblastoma and the malignant melanoma are most thoroughly covered. Less common neoplasms are illustrated and described quite thoroughly. There are a number of valuable tables. There is a satisfactory but not extensive bibliography. The compendium is valuable as a single text, as well as a part of the whole series.

—*Mark C. Wheelock.*

THE 75,000 WORD MONOGRAPH, entitled *A Contribution to the Study of Portal Hypertension*,[9] prepared in essay form for the Royal College of Surgeons, should be in the library of anyone doing abdominal surgery, and also of the internist. It is a splendid summary of all aspects of portal hypertension and would be of tremendous interest to all medical students beyond the first 2 years of training. The anatomy, hemodynamics, pathology, and the surgical consideration of every condition known to affect the extrasystemic circulation of the portal system has been evaluated.

The management of the two hundred-fifty patients sent for surgical opinion over the past ten years has resulted from the co-operative decisions of both the surgeon and the medical man. This group of patients was handled in a remarkably practical fashion, and the surgeon's contributions are obvious. Professor Hunt and his colleagues used every possible means of determining the cause of portal hypertension. Many excellent venograms and drawings illustrate the probable etiology; whether congenital or acquired, whether due to extrahepatic or intrahepatic obstructions. The discussion of forward thrust or backward pressure changes is most illuminating. Pressure changes and speed of flow by three different methods are well documented. The author believes that venograms are all that will be necessary to determine the indications for surgery. These relatively simple procedures permit the proper operations to be used expeditiously.

The cases were followed thoroughly. Postmortem studies are presented in a most complete fashion, and the results and reasons for the surgical procedures used are clearly shown.

This essay won the Jacksonian prize of the Royal College of Surgeons in 1956, and should stand as an epic contribution to our complete understanding of the subject. —*Donald C. Balfour, Jr.*

TEN YEARS HAVE ELAPSED since publication of the first edition of the book entitled *Reconstructive and Reparative Surgery*. Experiences gained in World War II stimulated the use of new techniques which have since been evaluated in civilian practice and have been incorporated in the second[10] edition.

The book has five divisions. Division one includes general technique, grafting of tissue, transplantation of flaps, and treatment of burns, wounds, and scars. Divisions two to four demonstrate the various reconstructive principles in different parts of the body: head and neck, trunk, extremities other than the hand and foot, and hand and foot. These chapters have been subdivided, whenever possible, under headings: Defects, Deformities (or Dysfunctions). The last section of the book represents illustrative cases and histories.

This volume will be of great value to the general surgeon who is called upon to do reparative surgery, to the orthopedic surgeon who frequently is confronted with reconstructive problems, and to the general practitioner who so frequently sees patients with conditions beyond his capabilities but which he wishes to discuss in detail with them.

The illustrations are large and beautifully portrayed. Not all plastic surgeons would agree with

[6]TUMORS OF THE KIDNEY, RENAL PELVIS, AND URETER. By Balduin Lucke, M.D., Dr. P.H., and Hans G. Schlumberger, M.D. Section VIII, Fascicle 30. 208 pages, 187 illustrations. $2.25. Washington, D. C.: Armed Forces Institute of Pathology, 1957.

[7]TUMORS OF THE PITUITARY GLAND AND INFUNDIBULUM. By James W. Kernoham, M.D., and George P. Sayre, M.D. Section X, Fascicle 36. 81 pages, 67 illustrations. $1.00. Washington, D. C.: Armed Forces Institute of Pathology, 1956.

[8]TUMORS OF THE EYE AND ADNEXA. By Algernon B. Reese, M.D. Section X, Fascicle 38. 205 pages, 122 illustrations. $2.00. Washington, D. C.: Armed Forces Institute of Pathology, 1956.

[9]JACKSONIAN PRIZE ESSAY ROYAL COLLEGE OF SURGEONS 1956. A CONTRIBUTION TO THE STUDY OF PORTAL HYPERTENSION. By Alan Henderson Hunt, M.A., D.M., M.Ch., F.R.C.S. 230 pages, illustrated. $8.50. Edinburgh and London: E. & S. Livingstone Ltd., 1958.

[10]RECONSTRUCTIVE AND REPARATIVE SURGERY. By Hans May, M.D., F.A.C.S. 2nd ed. 1115 pages, 1030 illustrations (55 in color). $30.00. Philadelphia: F. A. Davis Co., 1958.

methods of planning, such as the one illustrated in Figure 41 where a tubed pedicle, prepared in the cervical region to repair a cheek defect, would leave an unsightly scar on the neck. A lower cervical tube would leave the scar along the lines of skin folds.

Revisions and additions are noted in fields in which great strides have been made in recent years, such as cleft lip repair, the pharyngeal flap, tissue transplantation, and the use of new drugs. The section on mammaplasty has been modernized and older methods omitted. Inclusion of defects of the sphincter ani muscle and their repair is an addition to this volume.

The section on the extremities other than the hand and foot deals with many conditions which confront the general and orthopedic surgeon rather than the plastic surgeon, but this again emphasizes the value of the book as a reference volume.

Over 200 pages are devoted to reparative surgery of the hand. The author has drawn generously from the publications of the outstanding men in this field.

As in the previous edition, the final category of the book is devoted to illustrative cases with illustrative notes on technique and management. This part has been greatly enlarged and presents excellent material for teaching.

The bibliography is detailed. The book can be recommended as a valuable addition to any medical library and as a reference manual to any teaching program in surgery. —*W. H. Steffensen.*

IN A RELATIVELY SMALL VOLUME, J. Lawrence Pool and Arthur A. Pava[11] present the recent experience of the Neurological Institute of New York in the management of acoustic nerve tumors. They also briefly review the pertinent literature. Their source material consists of 135 patients with histologically verified eighth nerve tumors operated upon 162 times. The symptomatology of these tumors is described in considerable detail. Once again, the importance of the classical progression of symptoms as described by Harvey Cushing for the correct diagnosis is stressed. The technique of operation is well described as is the preoperative and postoperative care. The indications for total, as contrasted with subtotal, removal of the tumor are clearly stated. It is of interest to note that total removal was possible in 24 per cent of the cases. Also of interest is the fact that many of the patients did quite well for long periods of time following subtotal removal although in most a recurrence of symptoms was noted in a few years. The authors and their colleagues are to be congratulated on the good results which they have achieved in the treatment of these tumors and the authors for their fine presentation.

—*Nicholas Wetzel.*

THE COMPREHENSIVE and unusually well planned manual entitled *Clinical Proctology*[12] is designed primarily as a text and reference work for the general practitioner and general surgeon. Written with close attention to basic principles and technique, it will have a special appeal to the surgical or proctologic resident in training.

The beginning chapters cover anatomy and physiology and diagnostic procedures. Because of the author's wide experience in anorectal and pelvic anatomy, the text and original drawings take on a value far beyond those generally found in a book of this type.

Anal infections, hemorrhoidal disease, anal fissures, abscesses, fistula, and contractures, all of which are encountered in day to day practice (not always properly managed) are discussed so concisely and logically as to leave no unanswered questions in the reader's mind.

There is a considerable discussion of bowel disease from the diagnostic point of view, but the book deals principally and primarily with anorectal lesions.

The second edition of this well written book should be in the library of all practitioners and students of surgery. —*Thomas James Merar.*

THE THIRD EDITION of the splendid, widely approved treatise on *Urological Surgery*,[13] published in 1956, follows its preceding edition by 6 years. Individual chapters are devoted to anatomy of the urogenital tract, methods of diagnosis, preoperative and postoperative care and anesthesia. The remaining chapters deal either with the surgical aspects of a specific urologic disease—ureteral calculi, for example—or are devoted to surgical diseases involving a portion of the urogenital system, such as surgical conditions of the scrotum.

The material in three chapters which appeared in the preceding two editions has been deleted partially or entirely. These dealt with acid-base balance and fluid administration, blood transfusions and the treatment of shock, and radiation therapy. The chapter on the adrenal glands has been rewritten, and the chapter on neurogenic diseases of the bladder has been replaced by an excellent presentation of surgical treatment of dysfunction of the urinary tract caused by disease of, or injury to, the nervous system. A chapter dealing with postoperative urinary incontinence has been added, and the sections on ureterosigmoidostomy and perineal prostatectomy have been rewritten.

This book not only retains its enviable position as a source of information for the student interested in urologic surgery, but may be read with benefit by the trained urologic surgeon. The text is written in a straightforward, lucid manner and the abundant illustrations are clear and instructive.

It may appear captious, in view of the excellence of this book, to indicate several faults, but the omission of any discussion concerning the use of isolated segments of ileum, sigmoid, and cecum in urologic surgery is noteworthy. Furthermore, the chapter on endocrinology and endocrine treatment of the prostate, written for the preceding edition, has been kept un-

[11]THE EARLY DIAGNOSIS AND TREATMENT OF ACOUSTIC NERVE TUMORS. By J. Lawrence Pool, M.D., and Arthur A. Pava, M.D. Illustrations by Arthur A. Pava, M.D. 161 pages, 33 illustrations. $5.50. Springfield, Ill.: Charles C Thomas, 1957.

[12]CLINICAL PROCTOLOGY. By J. Peerman Nesselrod, M.Sc. (Med.), M.D., F.A.C.S., F.A.C.P. 2nd ed. 296 pages, 70 illustrations. Philadelphia and London: W.B. Saunders Co., 1957.

[13]UROLOGICAL SURGERY. By Austin Ingram Dodson, M.D., F.A.C.S. 3rd ed. 868 pages, 664 illustrations. $20.00. St. Louis: The C. V. Mosby Co., 1956.

altered as a tribute to the late Dr. Linwood D. Keyser. It is questionable, in view of the advances made in this field during the past 6 years, whether this decision was wise. —*Laurence F. Greene.*

THIS BOOK *Die postoperativen Fruehkomplikationen*[14] presents a comprehensive review of early postoperative complications and yields valuable information to the surgeon and anesthesiologist which too often is found only in scattered reports.

The first part of the book deals with the pathophysiology of the postoperative period—the complications of the respiratory system, of fluid and electrolyte balance, and of the cardiovascular system are discussed on the basis of the latest conceptions in these fields with emphasis toward the practical aspect.

In the second part, special complications are listed: those following thoracotomy, pulmonary and cardiac surgery, complications of diverse abdominal operations, of the endocrine glands, of orthopedic and neurosurgical procedures, of the management of severe burns, of tetanus, and the special complications encountered in pediatric and geriatric surgery.

The third part of the book gives a practical description of technical management for the prevention and treatment of postoperative complications. The routine practiced at the University Surgical Clinic of Freiburg, Germany is presented in detail. Pertinent information is given on all subjects from the management of respiratory and cardiovascular complications to the technique of intestinal intubation and the organization of a recovery ward. This interesting symposium on the pathophysiologic, clinical, and practical aspects of the important early postoperative period should be helpful to every practicing surgeon.
—*E. W. Ferbers.*

THE AUTHOR of the book entitled *Trophoblastic Growths; a Clinical Hormonal and Histopathologic Study of Hydatidiform Mole and Chorioepithelioma,*[15] J. Smalbraak, M.D., is a Dutch gynecologist. Obviously he is also an excellent histopathologist.

This edition of the book was translated into English and printed in the Netherlands. In general, the translation is excellent and the text reads smoothly. A few phrases do appear a little quaint, such as: "on revision of the slides" (meaning restudy of the slides, I believe); "a few days later she was mobilized" (meaning let out of bed); "nr" and "nrs" are used for No. and No's.; "estron level" is used for estrone level, although this probably is an error in proofreading.

Sixty-six photographs, 8 in color, are presented. Practically all are of superb quality, and all are full page size. This is most refreshing since in too many of the books and journals of our country photomicrographs are made at such low magnification or are so reduced by the publisher that imagination and a magnifying glass are needed to find what is described in the legend.

The review of the literature is exhaustive. In the early sections it does not seem too critical but in the latter portion becomes delightfully so.

The book is divided into two main sections. The first is devoted to hydatidiform moles. The tissues and histories of 74 patients were available to him. In 53 of these he obtained a sufficient number of blocks of good quality to classify them histologically, according to the method of Hertig, as to their malignant potentialities. He agrees with Hunt, Dockerty, and Randall that results of classification are in no way conclusive enough to determine treatment, but that the clinical course of the patient after removal of the mole is far more important than mere histologic study. Incidentally, in these 53 patients no choriocarcinomas developed. "Chorioepithelioma in situ" developed in 2 per cent, so called syncytial endometritis in 4 per cent, and chorioadenoma destruens, or perforating mole, in 7.5 per cent.

He believes that one should be as conservative as possible in treating moles and criticizes the use of x-ray treatment in several cases in his series. One intriguing case is described in which x-ray therapy was indicated after repeated reformation and passage of mole tissues. First, however, the patient was subjected to laparotomy to make the distance between the uterus and one normal ovary as great as possible. The new position of the latter was then shielded during x-ray therapy and 4 months later the patient resumed regular menses.

The second section deals with chorioepithelioma and contains an equally exhaustive review of the literature. The author presents the clinical details on chorioepitheliomas in 17 patients. Eight of these were preceded by full term pregnancies, 5 by abortions, and only 5 by molar pregnancies.

His criteria for the histologic diagnosis of chorioepithelioma are very rigorous. The purist would be disturbed by only 1, or perhaps 2, of his cases. In only 1 instance was some villous stroma observed. This patient died from her disease, however, and the second is listed as cured.

Seven of his 17 patients survived for from 6 to 24 years. Photomicrographs are very convincing for 4 of the 7. Case 6 is listed as "low grade malignancy" and the photomicrograph is not too convincing. This reviewer certainly could not say that it is not a true chorioepithelioma since he has not seen the original slides. There are no photographs for case 10 but here chorionic gonadotropin titers and cerebral involvement from which the patient ultimately recovered make it seem likely that this was a true instance of chorioepithelioma. There are no photomicrographs for case 15. The presence of metastases in both vagina and ovary makes the diagnosis of chorioepithelioma seem authentic.

A review of the literature on treatment is also included. The author's iconoclastic insistence that the ovaries should not be removed in these women (unless preclimacteric) delighted this reviewer. His decision, however, was not so much for psychogenic reasons or because of the infrequency of metastasis to this organ but because he thinks that perhaps the

[14] DIE POSTOPERATIVEN FRUEHKOMPLIKATIONEN; IHRE BEHANDLUNG UND VERHUETUNG. By Doz. Dr. Kurt Wiemers and Dr. Ernst Kern. Foreword by Prof. Dr. H. Krauss. 264 pages, 52 illustrations. DM 38.-. Stuttgart: Georg Thieme, 1957.

[15] TROPHOBLASTIC GROWTHS; A CLINICAL HORMONAL AND HISTOPATHOLOGIC STUDY OF HYDATIDIFORM MOLE AND CHORIOEPITHELIOMA. By J. Smalbraak, M.D. Introduction by the late Emil Novak, M.D., D.Sc. 342 pages, 66 illustrations. $12.75. Princeton: D. Van Nostrand Co., Inc., 1957.

ovarian hormones aid the defense of the body against metastatic lesions. For this latter reason he advocates the administration of 100.0 milligrams a day of stilbestrol if patients have metastatic lesions. His faith in the value of x-ray therapy and intravenous nitrogen mustard is not very great. Information on the probable value of intravenous methotrexate was probably not available to him at the time he wrote the book.

It is obvious that the reviewer admired this book. It should be read not only by the gynecologist but should also be required reading by pathologists, since they are the ones ultimately responsible for the diagnosis and thus indirectly for the treatment of the patient. —*Ronald R. Greene.*

THE INTERESTING VOLUME entitled *Le foie; études anatomiques et chirurgicales*,[16] by Dr. C. Couinaud is divided into two parts. The first is devoted to gross anatomic studies and to the variations in distribution of the vessels and bile ducts within the hepatic lobes and hilus as demonstrated by the corrosion cast method. The external configuration and its variants are also studied. The division of the liver into segments, according to the branching of vessels and ducts, is carefully determined and well illustrated with drawings and statistical studies of the variants that may be encountered.

The second part of the book deals with surgical procedures applicable to the liver, without extensive discussion of the therapeutic indications. Descriptions of different incisions to approach the hepatic lobes, varied techniques for carrying out lobectomy, segmentary resections and drainage of amputated bile ducts, as well as peritonization are explained in detail. Emphasis is placed upon the necessity for preoperative examination by cholangiographic and portographic studies to determine the topography of vessels, ducts, and lesions before major surgery is carried out. The last chapter describes surgical techniques for approaching the hepatic hilus.

This volume is recommended as a valuable guide for surgeons interested in the new field of liver surgery. —*Hector Marquez.*

THE MATERIAL in the book *Maladies des veines*[17] is based on the experience of 20 years at the Salpêtrière in Paris. It is divided into 9 parts: diagnosis of recent venous thrombosis, treatment of recent venous thrombosis, pulmonary embolus, prophylaxis of thromboembolism, varices, complications of varices, symptomatic varices from vascular malformations, old venous thrombosis, and phlebography.

The text is well organized and the 342 illustrations are clear and well suited to the contents. Every possible aspect of diagnosis and treatment is considered and the author seems to have made a special effort to make his work complete. The bibliography is excellent. Many diagnostic techniques and operative procedures are explained in minute detail.

This volume will be of value primarily to the specialist who spends much of his time in the study and treatment of the diseases of veins. —*Maurice LeClair.*

THE VOLUME *Fundamentals of General Surgery*,[18] by Gius, is written primarily for undergraduate medical students. As stated by the author in the preface, it lists the "fundamentals of the study of general surgery, including certain aspects of physiology and pathology." Technical procedures have been omitted.

The first chapters deal with various general conditions—wound healing, fluid and electrolyte balance, shock and hemorrhage, surgical infections, and burns. These are all excellently written and with marked emphasis on the pathophysiologic principles, but examples of their clinical application are also brought out. Terse statements such as "Treat the patient, not the lab report" emphasize to the student the fact that common sense is necessary in surgical practice. There are excellent chapters on preoperative and postoperative care, which are as important as the operation itself. Too often, a technically excellent operation may be performed, but because of inadequate or improper preoperative and postoperative care the end results leave much to be desired.

The author continues with the surgical problems encountered in the gastrointestinal system, the liver, pancreas, and spleen. These chapters are concise and to the point. Attention is paid to the pathophysiology, history, physical examination, and signs and symptoms. The necessary surgical procedures are mentioned, but no techniques are given. Acute conditions of the abdomen are covered in an important chapter. This is really a differential diagnosis of acute abdominal conditions. It is concise but inclusive, and should be a great help to the medical student, who can correlate various symptoms and signs by studying this chapter—not once, but several times. The author, in several chapters, emphasizes the fact that the important point in the presence of an acute abdominal condition is to determine whether one is faced with a surgical problem. He indicates that oftentimes the exact pathologic entity cannot be determined before laparotomy, but if it is believed that a surgical condition exists, the abdomen should be opened and the exact diagnosis established. Diagnoses in order of probability should be listed before operation. The author's statement on the treatment of acute uncomplicated appendicitis, "There is nothing to be gained by prolonged observation, antibiotic treatment, and procrastination. In most instances, the patient should be ready for operation within an hour or two after hospital admission" is to be commended.

The last few chapters deal with peripheral vascular disease, fractures, and head and chest injuries. These are discussed briefly, since they do not fall in the category of general surgery.

The table of contents is all inclusive. The illustrations throughout are satisfactory, although more illustrations would probably enhance the value of the

[16]LE FOIE; ÉTUDES ANATOMIQUES ET CHIRURGICALES. By C. Couinaud. 530 pages, 256 illustrations. 4,500 fr. Paris: Masson & Cie, 1957.

[17]MALADIES DES VEINES; DIAGNOSTIC ET TRAITEMENT. By Claude Olivier. 1st ed. 600 pages, 342 illustrations. 6,700 fr. Paris: Masson & Cie, 1957.

[18]FUNDAMENTALS OF GENERAL SURGERY. By John Armes Gius, M.D., F.A.C.S. 720 pages, 250 illustrations. $12.50. Chicago: The Year Book Publishers, Inc., 1957.

volume. Various tables throughout the volume can be of great help to the student. The references at the end of each chapter are an excellent guide to further reading by the student. The index is detailed, so that any topic discussed can be found without difficulty.

This text should be an excellent one for the undergraduate medical student. Practicing physicians, both general practitioners and specialists, will also be benefited by studying this volume.

—*Walter W. Wollmann.*

THE CORE of the 400 page book *Spontaneous and Habitual Abortion*[19] is a 7 year study of 2,545 cases. The work was carried out in the pathology laboratory of the Department of Obstetrics and Gynecology of the New York Hospital-Cornell Medical Center. Clinical management of the pregnant woman was uppermost in the author's mind when this book was written. Prevention of spontaneous abortion is one of the major themes. The psychologic aspect of the problem with its sociologic and cultural ramifications is thoroughly discussed.

The book is generously illustrated with excellent photographs and photomicrographs of abortion specimens. Contrary to popular opinion, Javert's research shows that cord complications cause more than 53 per cent of all abortions and only 35 per cent can be ascribed to a pathologic ovofetus. He also stresses the high incidence of decidual hemorrhage in the abortion material—61 as against 3.5 per cent in total pregnancies.

Great emphasis is placed on the psychosomatic approach for the prevention of habitual abortion and the role of the obstetrician as "family doctor" and "doctor-priest" in the care of prospective mothers as complete individuals is stressed. The doctor should be much more than a scientific technician checking only the blood pressure and urine periodically. Preconceptional interviews with the husband are encouraged. "Tender loving care" throughout gestation, along with a liberal diet and generous supplements of vitamins C, K, P, calcium lactate, and iron form the basis of management. Hormones are not used, in fact, Javert believes they are contraindicated. The abortion rate in habitual aborters was reduced from 95 to 28 per cent in the 146 patients under the author's care.

This book is well organized and contains a large amount of statistical material in a concise form. It is well designed and easy to read. Pertinent cartoon-type sketches are used to illustrate the various problems of pregnant patients. Each cartoon speaks volumes and provides refreshing insight for the reader. The 26 case studies which are presented are concise and realistic.

This book is factual, well backed by statistical and pathologic studies, and written in a warm personal manner. It fills a void of some 20 years since the publication of Taussig's classic work on abortions. This work will provide stimulating reading for both doctors and medical students. —*Charlotte Herman Kerr.*

[19] SPONTANEOUS AND HABITUAL ABORTION. By Carl T. Javert, M.D. 450 pages, illustrated. $11.00. New York: McGraw-Hill Book Co., 1957.

IN THE BOOK, *An Atlas of Cardiac Surgery*,[20] Jorge A. Rodriguez reveals his talent as an artist, his intense interest in cardiac surgery, and his industry in accomplishing his objective: "to compile an atlas of standard procedures used today." He is to be commended.

The first section of the atlas deals with the surgical anatomy of the heart and great vessels based on the author's dissections.

Rodriguez visited 24 of the leading cardiovascular surgeons of this country and has drawn, step by step, 29 surgical procedures for congenital or acquired disease of the heart and great vessels that were developed or used by them. There is a brief discussion of each entity. The black and white drawings are clear and well labeled. The author gives full credit to the 24 surgeons and takes full responsibility for his interpretations and presentations.

Open cardiac surgery, using hypothermia or the mechanical devices for by-passing the heart and lungs is illustrated.

The atlas will be of particular help to interns and residents, as well as those who are interested in reviewing cardiovascular surgical procedures.

—*E. H. Fell.*

THE PRINCIPAL VALUE of the symposium organized by the Council for International Organizations of Medical Sciences lies in the exchange of ideas regarding current research on the reticuloendothelial system. All of the information that will be of value to the practicing surgeon can be obtained by reading the sections in *Physiopathology of the Reticulo-Endothelial System*[21] by C. A. Doan and the summing-up by the editor, B. N. Halpern. The remainder is highly technical, chiefly experimental, and not directly related to functions in the human in many sections.

The functions of the reticuloendothelial cells are described from cleverly contrived experiments testing the physical-chemical factors of particle phagocytosis. This function is studied with microbial pathogens, with radioactive and inert colloids, and dyes. A general discussion of the factors inherent in the major organs of the reticuloendothelial system—the liver and spleen—is correlated with iron metabolism. The physiologic and pathologic destruction of blood cells is discussed in detail. Normally, the reticuloendothelial system removes only devitalized blood cells. The various pathologic states in which blood cells of normal vitality are destroyed are discussed. Surgeons will note that hereditary disorders of the corpuscles with a normal reticuloendothelial system are not improved by splenectomy, e.g., congenital hemolytic jaundice, Cooley's anemia, and sickle cell anemia. Disorders of blood due to factors outside the corpuscles are briefly considered, including the pathologic destruction of normal red cells by the reticuloendothelial system,

[20] AN ATLAS OF CARDIAC SURGERY. By Jorge A. Rodriguez, M.D. 250 pages, illustrated. $18.00. Philadelphia: W.B. Saunders Co., 1957.

[21] PHYSIOPATHOLOGY OF THE RETICULO-ENDOTHELIAL SYSTEM; A SYMPOSIUM ORGANIZED BY THE COUNCIL FOR INTERNATIONAL ORGANIZATIONS OF MEDICAL SCIENCES. Edited under the direction of B. N. Halpern by B. Benacerraf and J. F. Delafresnaye. 317 pages, illustrated. $9.00. Springfield, Ill.: Charles C Thomas, 1957.

e.g., the loosely defined "hypersplenism." For such disorders splenectomy is occasionally of value but no combination of known tests will reliably predict which cases will benefit.

The effect of cortisone in altering antibody reactions and tissue sensitivities is discussed. The experimental production of ascites by heavy liver radiation using radioactive colloids is interesting.

The papers are summarized in French, not always in English, and the illustrations are clear and relevant.

—William F. Pollock.

THE ENGAGINGLY WRITTEN little monograph *Plastic Arterial Grafts*[22] presents in a facile manner the history of arterial grafts, the history of the development of the Tapp-Edwards crimped nylon graft, and the application of the prosthesis to a number of arterial lesions amenable to graft procedures.

The book is timely and should interest all surgeons who treat vascular diseases for it represents a progress report in a field of rapidly developing changes. The author suggests that present day plastic grafts should not be construed as the ultimate device, but that knowledge about them may stimulate new research to master some of the many remaining problems.

The final chapter deals with unsolved problems in the field of plastic arterial grafts and discusses venous graft replacement, nonsuture techniques, cause of late graft thrombosis, and durability of grafts of various synthetic fabrics. The challenges set forth in this chapter may well provide the impetus to important future advances in this field of surgery.

—Harold Laufman.

A REGIONAL APPROACH to gynecologic surgery with emphasis on the regional organs as they are encountered in the treatment of genital cancer is given in the book entitled *Gynecologic Surgery and Urology*.[23] The urologic conditions discussed are incontinence of urine, urethral transplantation, selected operative procedures upon the urinary bladder, and some chosen minor types of urologic lesions. Proctology is limited to minor surgical conditions. Major bowel and rectal lesions, such as cancer, are not included. Hernias are described since they may be present in patients with gynecologic disease.

The principle procedures in gynecologic surgery are presented in clear and understandable drawings. Radiation therapy is most inclusive and is good. The abundant text material accompanying the surgical procedures gives to the reader a concise understanding of the author's opinions.

An excellent aspect of the book is the presentation of surgical anatomy. There is an outline, with index, of a convenient study plan for review of the surgical anatomy entailed in gynecologic surgery. It is most useful and to the point.

This book has considerable value since it represents not only the thinking of Doctor Ball, but also of his colleagues in the New York Hospital-Cornell Medical Center Group.

The manner in which this material is presented, the completeness with which it is covered, and the directness with which it is written make this book a very useful one. *—John I. Brewer.*

THE BOOK entitled *The Surgical Management of Pulmonary Tuberculosis*,[24] edited by John Steele and published by Charles C Thomas, is the first of a series of monographs on various phases of thoracic surgery to be called the John Alexander Monograph Series. This volume contains a short biography of Dr. Alexander by Cameron Haight, his long time associate, and the volume itself is composed of contributions by former trainees of Dr. Alexander. John Alexander was one of the truly great men of American Medicine. Not only was he a pioneer in the surgical treatment of pulmonary tuberculosis, and trained many young men to become thoracic surgeons, but above all he was a man of great courage. While flat on his back because of tuberculosis he wrote the first monograph on the surgery of pulmonary tuberculosis. It was awarded in 1925 the quintennial Samuel Gross prize of the Philadelphia Academy of Surgery and it was for many years the Bible of all who did surgery for pulmonary tuberculosis. During the rest of his life he was fighting the disease himself but never letting it interfere with his work. This new book contains much of the material he had collected for a book on the same subject. He had nearly completed the manuscript when he died. Rather than attempt to complete this work as he would have wished it done, it was decided to have his trainees include much of his material and some of their own as well. Although the book is basically the expression of the opinions of Dr. Alexander, especially in regard to thoracoplasty, some parts contain ideas with which he might not be in agreement, but for that reason its value is enhanced.

This book covers the subject from historical accounts to the very latest ideas about pulmonary resection. Every phase of the surgical treatment of pulmonary tuberculosis, as well as the subject of chemotherapy, is covered by men who are well qualified to do so. Many of the illustrations, especially those of thoracoplasty, are taken from Alexander's other books and papers. The remainder are of excellent quality and add much to the value of the book. This is a volume that everyone interested in pulmonary tuberculosis will wish to own and that every thoracic surgeon will find invaluable. *—Richard H. Meade.*

THE WORK *Traumatologia del sistema nervoso*[25] in fact comprises 3 monographs under one cover: (1) Traumatic Lesions of the Peripheral Nerves, (2) Traumatic Lesions of the Spinal Cord, and (3) Traumatic Lesions of the Brain. The book brings up to date and enlarges, with emphasis on the anatomy and physiology

[22]PLASTIC ARTERIAL GRAFTS. By W. Sterling Edwards, M.D. 126 pages, illustrated. $4.50. Springfield, Ill.: Charles C Thomas, 1957.

[23]GYNECOLOGIC SURGERY AND UROLOGY. By Thomas L. Ball, M.D. With foreword by R. Gordon Douglas, M.D. Illustrated by Daisy Stilwell. 547 pages, 161 illustrations. $20.00. St. Louis: C. V. Mosby Co., 1957.

[24]THE SURGICAL MANAGEMENT OF PULMONARY TUBERCULOSIS. Edited by John D. Steele, M.D. Introduction by Frederick A. Coller, M.D. Biographical Sketch of John Alexander by Cameron Haight, M.D. 213 pages, illustrated. $9.50. Springfield, Ill.: Charles C Thomas, 1957.

[25]TRAUMATOLOGIA DEL SISTEMA NERVOSO. By Angelo Chiasserini. 777 pages, illustrated. L. 9,000. Rome: Società Editrice Universo, 1957.

of the nervous system in relation to the surgery of trauma, 2 previous publications by the author in 1944 and 1947. Drawing liberally upon the world literature, Chiasserini emphasizes the importance of trauma to the nervous system in *everyday life*, in contrast to so many works which rely upon military experience, and the discussions of therapy as developed during the past decade are supported by current concepts of neurophysiology and neuropathology.

Of 400 cases of peripheral nerve injury, 1941 to 1944, 40 involved the brachial plexus, and of 300 operations in this series, 25 were on the plexus. The author stresses the point that since most plexus lesions are incomplete they should be treated extensively by physical therapy. Direct trauma to the plexus, with anatomic division of nerves, can best be handled by surgical correction that is *not too long delayed*, after the lesion has been localized with absolute accuracy.

The treatment of spinal cord injury is reviewed in great detail as to recent versus old injury, anatomic levels, severity of lesion, and complications, and many other authors are quoted. There is nothing particularly new or revolutionary, or containing fresh hope as to the result of therapy which the author has to propose. He apparently believes, on the basis of a rather limited experience, that there is promise in the bilateral anastomosis of peripheral nerves (as the ulnars and intercostals) with roots of the cauda equina in the presence of irreparable damage to the thoracic cord.

With the present day availability of good anatomic references, the space given to the structure of the cranium and its contents is somewhat over-long. The discussion of post-traumatic epilepsy is based on a concise review of recent advances in the pathology and treatment of this complication. The monograph offers many practical suggestions for the treatment of the acute complications of severe closed head injury, such as prolonged coma, respiratory difficulty, disturbance of the heat regulatory mechanism, cardiovascular changes, uncontrollable motor activity, and abnormal excretory changes.

This volume, written in an easy and informal style and with good co-ordination of material, does not offer much that is not already known to the experienced neurosurgeon, but it does reflect the author's career of wide experience and good surgical procedures. Unfortunately, many of the illustrations are not only outdated (as those of Flatau, Erb, Sobotta, Hovelacque) and thus detract from the freshness of the text, but many of them, especially the photographs, are poorly reproduced. There is a good subject index as well as a listing of the large number of authors quoted. —*John Martin.*

THE LARGE AND COMPREHENSIVE TREATISE, *Gastro-Intestinal Obstruction*,[26] will soon be in all good surgical libraries. It is written in the style and has the format of an advanced textbook which enhances its value as a reference book. There are 415 black and white photographs and line drawings which adequately illustrate the text. Thirty-eight pages of an alphabetically arranged bibliography and an index increase the usefulness of the book.

In general, the opinions expressed by the authors are quite orthodox, representing the consensus of modern surgical opinion. In the preface it is stated: "We are firmly convinced that all cases of intestinal obstruction of a mechanical nature should be operated upon as soon as they can be properly prepared." It is thought that any further reduction in the present mortality rate of intestinal obstruction which is estimated to be from 10 to 15 per cent will probably come about only by earlier diagnosis and better understanding of the pathologic physiology of this condition. That there is a great need for improvement in these phases of the problem has been recently forcibly brought home to the reviewer during the course of grading state licensing board examinations.

The pattern of the book is such that the various anatomic lesions producing obstruction in the different anatomic divisions of the gastrointestinal tract are given in sequence. Details of treatment are reserved for later chapters. This, no doubt, has minimized the amount of repetition which would have been otherwise necessary but may detract from the usefulness of the book to the busy practicing surgeon.

As is true of any book, the special interests of the authors are reflected. Sixty-four pages are devoted to a discussion of gastrointestinal intubation, while the surgical management of gastrointestinal obstruction is disposed of in only 37 pages. A more detailed discussion of the technique of immediate decompression at operation by catheter or sound would be appropriate. Enterostomy has been relegated "to the limbo of the past," but we believe that Witzel's operation is still a good procedure and should remain in the repertory of any surgeon who treats intestinal obstruction even though it may not be used as frequently as in years gone by.

The last 5 chapters of the book deal with subjects which are frequently covered cursorily and vaguely by other treatises on intestinal obstruction. The 6 pages devoted to "Nursing Technic in the Management of the Obstructed Patient" contain much good advice, based on the personal experience of the authors. The minor role which drugs should play in the management of intestinal obstruction is well covered. In spite of continuing investigations, some doubt still remains as to the exact mechanism of death in some types of obstruction. In the last chapter, this subject is discussed in a critical fashion and reasonable conclusions drawn on the basis of known facts.

The authors are to be congratulated on a most worthwhile contribution to the surgical literature. We believe that this book will take its place as one of the two best modern books on the subject of intestinal obstruction. —*John R. Paine.*

THE THIRD EDITION of the well established text, *Pathology*,[27] not only maintains the high standards of

[26] GASTRO-INTESTINAL OBSTRUCTION. By Meyer O. Cantor, M.D., M.S., F.A.C.S., and Roland P. Reynolds, M.D., F.A.C.S. With contributions by Clifford D. Benson, M.D., F.A.C.S., Robert E. L. Berry, M.D., F.A.C.S., and William A. Hudson, M.S., F.A.C.S. 565 pages, illustrated. $18.00. Baltimore: Williams & Wilkins Co., 1957.

[27] PATHOLOGY. Edited by W. A. D. Anderson, M.A., F.A.C.P., F.C.A.P. 3rd ed. 1402 pages, 1294 illustrations, and 11 color plates. $16.00. St. Louis: C. V. Mosby Co., 1957.

its 2 predecessors but also surpasses them. There has been some deletion of outmoded material and inclusion of new concepts. Despite this change, there has been no increase in size. In most of the sections many of the respective authors have added new items in the bibliography. There have also been a fair number of appropriate changes in the photographs and photomicrographs.

This reviewer suggests that more use could be made of the common lesions as the basis for illustration. He also believes that better use could be made of the colored plates, as is done in the multiple ones after page 746 of the gastrointestinal tract, and that replacements should be made for the ones of rabies virus and molluscum contagiosum. These seem to be wasted. There might also be some enhancement of the text by the more extensive use of tables, charts, and diagrams.

Three new section writers replace 2 of the former ones and, with due respect to the latter, it is the belief that the text has benefited markedly. A. T. Hertig and Hazel Mansell have organized a splendid chapter on the female reproductive system. Dorothy Russell has done a similar alteration on the pituitary gland. Their views are more in keeping with those expressed by most pathologists and will enable the students and their instructors to deal with the subjects more successfully.

As might be expected, there is some overlapping in a multiple authored textbook although the editor has managed to keep this at a minimum. His selection of writers includes those who are listed as authorities in their respective fields. Obviously, he has allowed them complete freedom as there are no notes interspersed concerning different controversial subjects. This may have added some spice.

This volume will retain its position as one of the standard teaching texts used in many of the medical schools and should prove to be equally valuable to practitioners who wish to maintain their knowledge of pathology. It will also become a "well-thumbed" member of the university and hospital libraries.

—*Mark C. Wheelock.*

On March 19 and 20, 1957, a conference on *Hypophysectomy*[28] was held at the Sloan-Kettering Institute in New York at the suggestion of C. P. Rhoads. Among those present were Rolf Luft, Bronson Ray, and B. J. Kennedy as representatives of those who have recently contributed studies to this problem.

In essence, this small volume may be considered to bring together a considerable body of information not otherwise readily available. The techniques of hypophysectomy, surgical and otherwise, are discussed as well as are the results thus far achieved, particularly in carcinoma of the breast and diabetes mellitus. The physiologic effects of extirpation of the pituitary are well outlined.

In reviewing this book, one is struck by what would seem to be a considerable variation particularly insofar as preoperative hormonal treatment is concerned. There would also seem to be a divergence of views as to the necessity of a functionally complete hypophysectomy as opposed to a histologically complete hypophysectomy, i.e., no pituitary cells visible on serial section of the sella at autopsy. In view of this, one wonders if it is really necessary to treat the sella with both sodium hydroxide and Zenker's fluid and thus damage the right optic nerve. Surely good results from both an academic standpoint and also from a practical standpoint have been achieved in a high percentage of cases without such violent treatment.

In all, this is a very worthwhile book for one interested in this subject and can thus be heartily recommended.

—*Nicholas Wetzel.*

The brief well written volume *New Research Techniques of Neuroanatomy*[29] is the result of a symposium recently held under the sponsorship of the National Multiple Sclerosis Society. Some 10 contributors discuss the recent advance in research techniques for the nervous system, particularly in so far as electron microscopy, histochemistry, microbiochemistry, and tissue culture are concerned.

Although this small volume would certainly not help the general surgeon in the every day practice of surgery, it should perform a valuable function for those interested in the nervous system in calling to their attention recent technical advances in their field.

—*Nicholas Wetzel.*

The sixth edition of *Surgical Technique and Principles of Operative Surgery*[30] by A. V. Partipilo is a greatly enhanced and improved book. Thirty-eight new chapters have been added.

As is usual in a work of this scope, the author has called upon a number of collaborators to prepare certain sections, and approximately half of the chapters have been written by men who are specially interested in the subjects they discuss.

The work covers the technique of the common operations that are performed on the neck, thorax, abdomen, and rectum. The extremities are not covered except for a brief discussion of peripheral vascular disease, and varicose veins, and the only discussion of surgery of the head is a chapter on the salivary glands.

As the title indicates the book is primarily a book on operative techniques, and in this it is admirably successful. A clear, concise description of the author's technique is given for each procedure. The descriptions are supplemented by numerous fine illustrations.

The author states that it would be impossible to discuss all the modifications of each procedure, and he has purposely limited the description to one method of performing each operation.

The book is not limited solely to descriptions of operative techniques; one of the things that makes the work more useful consists of the concise sections devoted to the pathologic, physiologic, and clinical

[28] Hypophysectomy. Edited by O. H. Pearson, M.D., F.A.C.P. 154 pages. $5.00. Springfield, Ill.: Charles C Thomas, 1957.

[29] New Research Techniques of Neuroanatomy; a Symposium Sponsored by the National Multiple Sclerosis Society. Edited by William F. Windle, Ph.D., Sc.D. Foreword by Frederick L. Stone, Ph.D. 98 pages, illustrated. $4.75. Springfield, Ill.: Charles C Thomas, 1957.

[30] Surgical Technique and Principles of Operative Surgery. By A. V. Partipilo, M.D., F.A.C.S. Foreword by Alton Ochsner, M.D., F.A.C.S. 6th ed., thoroughly revised. 966 pages, 719 figures containing 1235 illustrations, 4 in color. $20.00. Philadelphia: Lea & Febiger, 1957.

aspects of each subject. There are also interesting chapters on fluid therapy, anesthesia, blood transfusions, radioisotopes, and radiation.

All in all, this is a useful and readable book which can be highly recommended. —*John W. Hirshfeld.*

THE LONG expressed need for an adequate histologic portrayal of such a format as its name suggests is fulfilled in *An Atlas of Fetal and Neonatal Histology*.[31] Actually, it covers a period of time from 4 months' gestation through birth into early childhood, during which time many of the major organs undergo rapid morphologic changes. From month to month or from weight group to weight group, the implications are obvious when one considers the fact that the understanding of pathology presupposes a thorough familiarity with the normal histology.

The major organs are presented in separate chapters. Each section begins with a brief summary of developmental and anatomic highlights, followed by a series of well documented photomicrographs of segmentally arranged cases accompanied by simple, concise explanatory texts pointing out salient histologic features. Recognition of certain marked differences between various age periods or weight groups is stressed. An extensive bibliography concludes each section. The final chapters are devoted to résumés of case data in table form and sets of pertinent normal values.

Except for the absence of an index which this reviewer thinks might be helpful for purposes of quick reference, the book is entirely satisfactory. The arrangement is practical and attractive and the quality of the photomicrographs excellent.

—*Mark C. Wheelock.*

A BRIEF REVIEW of the surgical technique for removing cancer of the lower lip, mandible, mouth, palate, antrum, thyroid, and larynx is given in the volume entitled *Tumor Surgery of the Head and Neck*.[32] The need for neck dissection in the treatment of cancer in these locations is emphasized, and tracheotomy is illustrated and discussed in detail. Salivary gland tumors are included. —*Minot P. Fryer.*

THE BOOK entitled *Recent Advances in Urology*,[33] edited by Howard G. Hanley, is a brief presentation by a group of British authors of recent advances made in the understanding, diagnosis, and treatment of diseases of the genitourinary organs and patients who suffer from them. The editor of this volume was fortunate in the selection of his 5 contributors; all did a creditable job. Throughout the book the subject matter is presented clearly and concisely. Adequate reference material is provided to allow the reader to pursue an interesting topic further. No attempt is made to cover the field of urology completely. However, the editor seems to have thoughtfully selected for discussion those aspects of urology in which vigorous current study is leading to rapid advances in our knowledge. As might be expected, the British attitudes are emphasized throughout the book. In many cases these differ considerably from the views of most American urologists. To many in this country the emphasis placed on avoiding preoperative urethral instrumentation of either a diagnostic or therapeutic nature in the management of vesical neck obstruction secondary to prostatic enlargement will seem unreasonable. To an increasing number the persistent skepticism regarding the value of total prostatovesiculectomy for early carcinoma of the prostate will seem unwarranted. However, the book derives much of its value from the fact that these differences in opinion are evident. They are thought-provoking and should provide a stimulus for the critical evaluation of procedures so often considered routine.

The book is divided into 14 chapters. The chapter dealing with fluid and electrolyte balance and renal failure provides a clear review of many of the important, recent contributions in this rapidly changing field. The chapters on carcinoma of the prostate, on bladder tumor, and on diversion of urine are particularly well written and informative. The chapter on prostatic obstruction tends to emphasize the advantages of the retropubic prostatectomy while minimizing its disadvantages. The chapter dealing with urinary lithiasis discusses such things as hyperparathyroidism, cystinuria, and the theories of stone formation briefly. The skepticism expressed regarding many of the recently advocated medical forms of therapy for patients with stones is refreshing. The chapter on conservative renal surgery provides an interesting brief discussion of the treatment of ureteropelvic junction obstruction. One has the impression that the British have less fear of accepting an aberrant vessel as the only cause of ureteropelvic junction obstruction than many Americans. The chapter on genitourinary tuberculosis emphasizes changing attitudes with regard to this disease since the advent of effective antibiotic and chemotherapeutic agents. The chapters on chemotherapy of urinary infections and surgery of the adrenal glands suffer from the fact that they deal with subjects on which data are accumulating at a rapid rate and in which attitudes are changing rapidly.

This book provides in an easily readable form a review by noted British authors of several important subjects in urology. It should prove both stimulating and informative to those with a special interest in this field. —*John T. Grayhack.*

THE AUTHOR, W. Barr Stirling, a specialist in urologic surgery at the Royal Infirmary in Glasgow, has written an interesting and factual volume on *Aortography*.[34] Throughout the book emphasis is placed on the value of aortography as it relates to the diagnosis and treatment of the major surgical lesions of the

[31] AN ATLAS OF FETAL AND NEONATAL HISTOLOGY. By Marie A. Valdes-Dapena, B.S., M.D. Foreword by Edith L. Potter, M.D. 200 pages, illustrated. $11.00. Philadelphia: J. B. Lippincott Co., 1957.

[32] TUMOR SURGERY OF THE HEAD AND NECK. By Dr. Robert S. Pollack. 101 pages, illustrated. $5.00. Philadelphia: Lea & Febiger, 1957.

[33] RECENT ADVANCES IN UROLOGY. By Howard G. Hanley, M.D., F.R.C.S. with the assistance of specialist contributors. 270 pages, 83 illustrations. $7.00. Boston: Little, Brown & Co., 1957.

[34] AORTOGRAPHY; ITS APPLICATION IN UROLOGICAL AND SOME OTHER CONDITIONS. By W. Barr Stirling, Ch.M., F.R.C.S. (Ed.), F.R.F.P.S.G. 292 pages, illustrated. $10.00. Edinburgh and London: E. & S. Livingstone Ltd.; Baltimore: Williams & Wilkins Co., 1957.

kidney. The experience in more than 500 personally performed aortograms is reviewed and presented, together with illustrative case histories to emphasize the important aspects of each problem. The role of aortography in the diagnosis of intrinsic vascular disease of the aorta and its major branches is also admirably presented and discussed.

It is interesting to trace the history and progress of contrast arteriography from its origins. Within a few weeks after the discovery by Roentgen in the 1890's of the properties of x-rays, reports of arteriographic studies in the autopsy room and on amputated extremities appeared in the literature. Many reports of the roentgenographic visualization of the vascular patterns in these specimens appeared around the turn of the century, but almost a generation was to elapse before the arteriographic technique was applied to the living human patient. Since that time rapid progress has been made and the procedure has become standardized in the human patient as it relates to the visualization of the central and peripheral vascular systems.

An excellent section is devoted to descriptive diagrams of the anatomy involved during the percutaneous passage of the needle into the aorta. A concise description of the technique of performing arteriograms is presented. The disturbances associated with the sudden increase in pressure within the aorta incident to the injection of the opaque material are discussed, not only on logical grounds but on physiologic ones as well. The effects of the velocity of injection and its influence upon the cardiac cycle are also described. An important section describes the hazards and complications of the procedure. It is interesting to note that when a complete understanding of all the problems of the procedure is attained, the difficulties resulting from the use of this valuable diagnostic aid are minimal.

Throughout the volume there are numerous reproductions of roentgenograms of the aorta, its major branches, and the kidneys, demonstrating the major pathologic conditions of the kidney and the associated arterial system. The use of illustrative case histories, accompanied by roentgenograms and descriptive diagrams, adds to the understanding of each problem. The material is presented in a precise and concise manner throughout the book. The text emphasizes and describes in detail the significant surgical and diagnostic criteria for operability of the major conditions affecting the kidney and adrenal glands.

This volume should serve well as a ready reference book, providing an understanding of the many problems associated with the aortographic technique. The book should in no way be considered a text, either of arteriographic diagnosis or of urologic practice, but admirably accomplishes its task of depicting all normal and abnormal configurations of the vascular pattern of the aorta and kidneys.

—*Orville F. Grimes.*

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

Traité d'anatomie humaine. By G. Paturet. Tome III, Fascicule I. Appareil circulatoire (à l'exclusion des veines). 663 pages, 402 illustrations. 11.000 fr. Fascicule II. Appareil circulatoire (veines) appareil de la phonation, appareil respiratoire, corps thyroide-parathyroides, thymus mediastin. 640 pages, 354 illustrations. 11.000 fr. Paris: Masson & Cie, 1958.

Skin Grafting. James Barrett Brown, M.D., and Frank McDowell, M.D. 3rd ed. 411 pages, 328 illustrations (6 color plates). $15.00. Philadelphia and Montreal: J. B. Lippincott Co., 1958.

Diseases of the Thyroid and Parathyroid Glands. By Bernard J. Ficarra, A.B., Sc.B., M.D., D.S. 295 pages, illustrated. $8.50. New York: Intercontinental Medical Book Corp., 1958.

Fifty Years of Neurosurgery. By Ernest Sachs, M.D. 186 pages, illustrated. $3.50. New York, Washington, Chicago, Hollywood, Toronto: Vantage Press, 1958.

Anomalies of Infants and Children. By D. McCullagh Mayer, D.D.S., M.D., F.A.C.S., F.I.C.S., and Wilson A. Swanker, M.D., F.A.C.S., F.I.C.S. 454 pages, 95 illustrations. $12.00. New York, Toronto, London: McGraw-Hill Book Co., Inc. (The Blakiston Division), 1958.

Diagnostic clinique prognostic et traitement des tumeurs benignes et malignes. By Ch-A Perret. Preface by Professor H. Redon. 892 pages, 184 illustrations. 7,600 fr. Paris: G. Doin & Cie, 1958.

Biophysical Principles of Electrocardiography. By Robert H. Baylet, M.D. Vol. I, 237 pages, illustrated. $8.00. New York: Paul B. Hoeber, Inc., 1958.

Abortion in the United States. Edited by Mary Steichen Calderone, M.D., M.S.P.H. 224 pages. $5.50. New York: Paul B. Hoeber, Inc., 1958.

Nouvelle pratique chirurgicale illustrée. By Jean Quenu. 296 pages, 260 illustrations. 3,300 fr. Paris: G. Doin & Cie, 1958.

Outline of Orthopaedics. By John Crawford Adams, M.D. (Lond.), F.R.C.S. (Eng.). 2nd ed. 428 pages, 298 illustrations. $8.00. Edinburgh and London: E. & S. Livingstone Ltd., 1958.

Oestrioluitscheiding in de Urine en de Anatomische Toestand van de Placenta. By G. J. W. H. Lenters. 160 pages, illustrated. Groningen: J. B. Wolters, 1958.

Psychoendocrinology. Edited by Max Reiss, M.D., D.Sc. 208 pages, illustrated. $7.00. New York and London: Grune & Stratton, 1958.

Tumori della vescica nei lavoratori delle amine aromatiche. By Ettore Mattea, M.D. 103 pages, 14 illustrations. 1,200 lire. Milan: Casa Editrice Ambrosiana, 1958.

Tuberculosis in Animals and Man. By John Francis, D.Sc., M.R.C.V.S. 357 pages, illustrated. $18.00. Baltimore: Williams & Wilkins Co., 1958.

AMERICAN COLLEGE OF SURGEONS

WILLIAM L. ESTES, JR., Bethlehem, Pennsylvania, *President*

NEWELL W. PHILPOTT, Montreal, Quebec, Canada, *President-Elect*

PRELIMINARY PLANS FOR THE 44th CLINICAL CONGRESS THE CONRAD HILTON HOTEL, CHICAGO, ILLINOIS OCTOBER 6 TO 10, 1958

IN THIS ISSUE, a preliminary outline of the color television program and 5 of the 9 Postgraduate Courses will be listed, along with general registration information for Clinical Congress week. A summary of the entire program will be carried in the September issue.

Dr. Gunnar Thorsén, Stockholm, Sweden, the second annual Baxter Lecturer in the field of parenteral therapy, will discuss the medical evolution and history of dextran, now 15 years old. His talk, Wednesday at 2 p.m., will evaluate clinical results of dextran and experimental horizons. He has written widely in this field.

Dr. Thorsén is associate professor in surgery at the Karolinska Institutet and head of the outpatient department at the university clinic in surgery at Serafimerlasarettet. He is also associate head of the department of general surgery at the same hospital and consulting surgeon for epidemic diseases. Dr. Thorsén studied at the University of Uppsala and the Karolinska Institutet in Stockholm receiving his medical degree in 1937, with postgraduate training at the university clinics in obstetrics and gynecology, neurosurgery, and general surgery. He continued postgraduate studies at the general hospital in Orebro, finishing at the Serafimerlasarettet.

Color Television

Procedures will originate from Passavant Memorial Hospital. The advance schedule, including the names of the operating surgeons, is listed in this issue. Moderators and panelists will be listed in the September issue of this journal.

MONDAY, 10 a.m.–12 noon.—Closure of Intra-Atrial Defect. F. JOHN LEWIS, Chicago. 2–3:30 p.m.—Herniated Nucleus Pulposus. LOYAL DAVIS, Chicago. 3:30–5 p.m.—Surgery of the Foot. EMIL D. W. HAUSER, WILLIAM A. LARMON, and JAMES K. STACK, Chicago.

TUESDAY, 10 a.m.–12 noon.—Pneumonectomy. THOMAS W. SHIELDS, Chicago. 2–3:30 p.m.—Flexor Tendon Graft. SUMNER L. KOCH and WILLIAM B. STROMBERG, Chicago. 3:30–5 p.m.—Excision Palmar Fascia for Dupuytren's Contracture. MICHAEL L. MASON and JOHN L. BELL, Chicago.

WEDNESDAY, 10–11 a.m.—Inguinal Hernioplasty. W. HARRISON MEHN, Chicago. 11 a.m.–12 noon.—Ventral Hernioplasty. HAROLD L. METHOD, Chicago. 2–3:30 p.m.—Radical Mastectomy. WALTER W. CARROLL, Chicago. 3:30–5 p.m.—Hypophysectomy. NICHOLAS WETZEL, Chicago.

THURSDAY, 10 a.m.–12 noon.—Neck Dissection with Hemimandibulectomy. ORION H. STUTEVILLE, Chicago. 2–3:15 p.m.—Diagnostic Gynecologic Problems. STUART ABEL, EDWIN J. DECOSTA, and JOHN W. HUFFMAN, Chicago. 3:15-4 p.m.—Anal Contracture. THOMAS J. MERAR, Chicago.

FRIDAY, 10–11 a.m.—Cesarean Section with Gastric Aspiration. RALPH A. REIS, Chicago. 11 a.m.–12 noon.—Vaginal Hysterectomy. JOHN I. BREWER, Chicago. 2–3:30 p.m.—Femoral Artery Bypass Graft. HAROLD LAUFMAN, Chicago. 3:30–5 p.m.—Cholecystectomy with Cholangiogram. B. FRANKLIN LOUNSBURY, Chicago.

Postgraduate Courses

This year 9 Postgraduate Courses are being presented. The broad outlines of 5 courses fol-

low. The September issue of this Journal will carry all the courses in detail, with names of teachers and subjects. Seven courses will be given Tuesday through Friday, 8:30 to 11:30 a.m.; Gynecology and Obstetrics will be given Monday through Thursday morning, with an "open" session on Friday to which nonregistrants may come; Surgical Aspects of Pulmonary Disease will be given afternoons, Monday through Thursday, 1:30 to 4:30.

Not outlined here are the courses on Gynecology and Obstetrics, Cardiovascular Surgery, Injuries and Other Disabilities of the Hip, and Surgical Aspects of Pulmonary Disease.

Since attendance is limited by the combination of two factors—the number who can be profitably instructed and the amount of space available—immediate registration to these valuable and popular courses is urged.

PREOPERATIVE AND POSTOPERATIVE CARE

DAVID V. HABIF, New York, Chairman.
8:30–11:30 a.m.

TUESDAY—Fluids and Electrolytes: Normal Body Composition Studies; Body Composition Disorders in Surgical Patients; The Control of Body Composition by Renal Function; The Reliability and Significance of Laboratory Tests in Surgical Patients; Degenerative Change in Organ Function (of Brain and Circulation) Due to Fluid and Electrolyte Disorders; Case Analysis Clinic.

WEDNESDAY—Nutrition for the Surgical Patient: Alimentary Route—Nasogastric Tube, Gastrostomy, Jejunostomy—Indications, Formulae, Management; Intravenous Route—What, How Much, When?; The Use of Testosterone Proprionate and Other Anabolic Hormones in Surgical Nutrition; Management of the Nutritionally Depleted Patient Undergoing Major Surgery; Nutritional Support of the Burned Patient; Present Status of Fat Emulsion for Intravenous Use; Feeding Problems Following Gastric Surgery; Case Analysis Clinic.

THURSDAY—Endocrinology and the Surgical Patient: Physiology of the Adrenal Gland—Normal and in Relation to Trauma; Hypoadrenal States Including Medical Steroid Therapy—Etiology, Diagnosis, Treatment; Preoperative and Postoperative Care of Patients Needing Adrenal Steroid Supplementation; Aldosterone and Sodium Metabolism in Trauma; Preoperative and Postoperative Management of Patients with Pheochromocytoma; Preoperative and Postoperative Management of Patients with Hyperparathyroidism; Case Analysis Clinic.

FRIDAY—Special Problems in Surgical Patients: Prophylactic Antibiotics in Elective Surgery; The Problem of Antibiotic Resistant Hospital Acquired Hemolytic Staphylococcus Aureus; Preoperative and Postoperative Management of Patients with Chronic Pulmonary Fibrosis, Emphysema, and Asthma; Bleeding Problems in the Surgical Patient; Surgical Shock as Seen Clinically Today: The Blood Volume, Myocardial Function, and Supportive Drugs; Case Analysis Clinic.

GASTROINTESTINAL TRACT

JOHN M. WAUGH, Rochester, Minnesota, Chairman.
8:30–11:30 a.m.

TUESDAY—Esophagus and Stomach: Tracheoesophageal Fistula; Benign Tumors of the Esophagus; Bleeding Esophageal Varices and Their Management; Perforation of the Esophagus; The Treatment of Acutely Perforating Peptic Ulcer; The Surgical Physiology and Treatment of Peptic Ulcer; The Management of Gastric Malignancy.

WEDNESDAY—Small Intestine: Malrotation—Its Diagnosis and Treatment; Early Operation for Small Bowel Obstruction; The Treatment of Diverticula of the Small Intestine; Regional Enteritis: Medical Aspects; The Surgical Management of Regional Enteritis; Clinical Aspects and Management of Functioning Carcinoid Tumors; Surgical Aspects of Tumors of the Small Intestine.

THURSDAY—Surgery of the Colon, Rectum, and Anus: New Trends in the Management of Diverticulitis; Volvulus of the Sigmoid; Ileostomy—Indications, Technique, and Care; Colostomy—Indications, Types, and Techniques; Fluid and Electrolyte Problems in Intestinal Surgery and Their Correction; Pancolectomy, Subtotal Colectomy, or Anal Ileostomy for Ulcerative Colitis; Treatment of Prolapse of the Rectum; Imperforate Anus.

FRIDAY—Surgery of the Colon, Rectum, and Anus: Antibiotics in Intestinal Surgery; The Indications for Total and Subtotal Colectomy in the Treatment of Cancer and Multiple Polyps of the Colon; Experiences with the Pull-Through Operation; The Management of Complications After the Miles Operation; Experiences with the "Second Look" Operation in Cancer of the Colon; The Treatment of Squamous Cell Epithelioma of the Anus; The Indications for and the Late Results of Pelvic Exenteration; Experience with the Rationale of Chemotherapy in the Treatment of Cancer of the Colon.

DISEASES OF THE LIVER, BILIARY TRACT, AND PANCREAS

WILLIAM D. HOLDEN, Cleveland, Chairman.
8:30–11:30 a.m.

TUESDAY—The Liver: Evaluation of Hepatic Function; Hepatoscan with Isotopes; Unusual Disorders

Producing Jaundice—Cholangiolitic Hepatitis, Chlorpromazine Hepatitis, and Homologous Serum Jaundice; Management of Hepatic Coma; Hepatic Resection; Management of Intrahepatic and Perihepatic Abscesses.

WEDNESDAY—Biliary Tract Surgery: Pathegenosis of Acute Cholecystitis; Bacteriology of the Extrahepatic Biliary Tract; Management of Acute Cholecystitis; Common Duct Exploration and Acute Cholecystitis; Primary Closure of the Common Duct; Extrahepatic Biliary Surgery in Children.

THURSDAY—The Sphincter of Oddi: Anatomy of the Sphincter; Physiology of the Sphincter; Indications for Sphincterotomy; Operative Cholangiography and the Sphincter; Technique of Sphincterotomy; Follow-up of Patients Having Had a Sphincterotomy.

FRIDAY—The Pancreas: The Natural History of Pancreatitis; Pancreatography; Pancreatic Jejunostomy; Pancreatic Cystogastrostomy; Resection of the Pancreas for Chronic Pancreatitis; Pancreatic Tumors and Peptic Ulcer; Pancreatectomy for Carcinoma of the Head of the Pancreas.

COMPLEX, COMBINED, AND COMPLICATED INJURIES

OSCAR P. HAMPTON, JR., St. Louis, Missouri, Chairman.

8:30–11:30 a.m.

TUESDAY—Skeletal Injuries of the Extremities Complicated by Other Life-Endangering Injuries: Evaluation and Treatment of Head Injuries; Evaluation and Treatment of Chest Injuries; Diagnosis and Treatment of Intra-abdominal Injuries in the Presence of Fractures of the Spine and Pelvis; Management of Severe Extremity Injuries in the Presence of Life-Endangering Injuries of Head, Chest, or Abdomen.

WEDNESDAY—Complex and Complicated Fractures and Fracture Dislocations of the Lower Extremity: Fractures and Fracture Dislocations of the Hip; Fractures and Fracture Dislocations of the Knee; Fractures and Fracture Dislocations of the Ankle; Fractures and Fracture Dislocations of the Foot.

THURSDAY—Complex and Complicated Long Bone Fractures: Operative Treatment; Nonoperative Treatment; Management of Multiple Fractures; Reconstruction of Malunion and Nonunion of Fractures.

FRIDAY—Complicated Wounds and Injuries of Soft and Skeletal Tissues: Management of Deep Wounds of the Extremities (Except Hand) Including Those of Open Fractures; Timing in the Repair of Complex Wounds of the Hand; Peripheral Nerve Injuries; Management of Patients with 30 to 50 Per Cent Burns.

PROBLEMS IN PEDIATRIC SURGERY

WILLIS J. POTTS, Chicago, Chairman.

8:30–11:30 a.m.

TUESDAY—General Considerations: Preparation of Child for Surgery—Physical and Psychological; Anesthesia and Temperature Control; Fluid Balance During Infancy; Postoperative Care Is Demanding.

WEDNESDAY—Common Problems in Pediatric Surgery: The Management of Hemangiomas; Inguinal and Umbilical Hernia; What About Undescended Testicles?; Pyloric Stenosis; Intussusception—To Operate or Not to Operate.

THURSDAY—Anomalies of the Gastrointestinal Tract: Roentgenography as an Aid in Diagnosis; Atresia of the Bowel; Imperforate Anus and Its Complications; Hirschsprung's Disease in Infancy.

FRIDAY—Respiratory Problems: Respiratory Infections in Surgical Wards; Respiratory Emergencies in the Newborn; Postpneumonic Lung Cysts; Pectus Excavatum.

Symposium on Graduate Training in Surgery and the Surgical Specialties

Dr. Robert M. Zollinger, Columbus, Chairman, Committee on Graduate Training in Surgery, will preside over the following program on Thursday at 2 p.m.:

Compensation of Residents in Federal Services. JOHN C. NUNEMAKER, Associate Secretary, Council on Medical Education and Hospitals, American Medical Association.

Panel: The Disappearing Service Patient. STANLEY O. HOERR, Cleveland, HAROLD A. ZINTEL, New York, MR. LAWRENCE HOWE, Attorney, Chicago, WARREN H. COLE, Chicago, ROBERT M. ZOLLINGER, Columbus, *Moderator*.

Forum on Fundamental Surgical Problems

Dr. Harris B. Shumacker, Jr., Indianapolis, Chairman, and the Forum Committee believe that this Forum on original research will be extremely interesting and useful. Morning and afternoon sessions are scheduled throughout the week, with general sessions and the following specialties represented: Gynecology and Obstetrics, Orthopedic Surgery, Plastic Surgery, Neurological Surgery, and Urology. The popular "What's New In Surgery" on Friday morning, the last morning of Congress week, will consist of reports by presiding officers of 6 or more of the Forum meetings, summarizing the major points made during the week.

Titles and authors of the approximately 200 papers to be presented will be announced in the next issue of this Journal.

Advisory Committee on Local Arrangements

Dr. Robert L. Schmitz, Chicago, heads the Advisory Committee on Arrangements for this forty-fourth Clinical Congress. The secretary is Dr. Frederick W. Preston, Chicago.

Members of the Committee from Chicago and its suburbs are: Drs. Cornelius M. Annan, M. Fletcher Austin, Thomas G. Baffes, John L. Bell, Walter W. Carroll, Dwight E. Clark, T. Howard Clarke, John B. Condon, David N. Danforth, Carl Davis, Jr., Frederic A. DePeyster, Walter F. Dillon, Tilden C. Everson, Paul F. Fox, John L. Grout, Paul V. Harper, Charles V. Heck, Myron M. Hipskind, Kenneth C. Johnston, John L. Keeley, Hiram T. Langston, William M. Lees, Thomas J. Merar, Peter V. Moulder, Frank W. Newell, John H. Olwin, David Presman, Stephen E. Reid, William L. Riker, Kenneth L. Roper, Charles A. Schiff, J. K. Sokol, David H. Wagner, and Nicholas Wetzel.

Mrs. Myron M. Hipskind heads the Ladies Entertainment Committee, and all ladies attending are assured a week of interest and recreation.

Registration Information

Special forms for advance registration, hotel accommodations, postgraduate courses, and travel have been mailed to Fellows of the College, and will be mailed to non-Fellows upon request. Prior registration is advisable, if at all possible, for it eliminates waiting in line to obtain the necessary badge of admission to Congress events and affords greater assurance of obtaining your choice of Postgraduate Course and other accommodations.

Anyone unable to register in advance may present his credentials at the central registration desk at The Conrad Hilton Hotel. The hours there are as follows:

SUNDAY, October 5, 3 to 7:30 p.m.
MONDAY, October 6, 8 a.m. to 5:30 p.m.
TUESDAY, October 7, through FRIDAY, October 10, 8 a.m. to 5 p.m.

Fees

Fellows whose dues are paid to December 31, 1957, pay no registration fee. Those who have not paid dues up to date must pay the registration fee of $20.00.

Non-Fellows pay a $20.00 registration fee, and members of the Federal Services pay $10.00. No fee (except for the Postgraduate Courses) is required of Initiates, members of the Candidate Group, and Surgical Residents. Surgical Residents are requested to present a letter of identification signed by the administrator of the hospital with which they are affiliated.

Everyone who attends a Postgraduate Course pays the nominal $5.00 fee.